AMUNDSEN SCIENCE

2018 | Expedition Report

CCGS *Amundsen*

LEG 1
BaySys

LEG 2A
Sentinel North BriGHT / BaySys

LEG 2B
Sentinel North PhD School & BOND

LEG 2C
Vulnerable Marine Ecosystem ROV
Program / DFO / ArcticNet Frobisher & HiBio

LEG 3
Kitikmeot / ArcticNet

Amundsen Science
Université Laval
Pavillon Alexandre-Vachon, room 4081
1045, avenue de la Médecine
Québec, QC, G1V 0A6
CANADA
www.amundsen.ulaval.ca

Camille Wilhelmy
Amundsen Expedition Reports Editor
camille.wilhelmy@as.ulaval.ca

Anissa Merzouk
Amundsen Science Project Coordinator
anissa.merzouk@arcticnet.ulaval.ca

Alexandre Forest
Amundsen Science Executive Director
alexandre.forest@as.ulaval.ca

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2018 Expedition Report

The 2018 Expedition Report is a collection of all the participating research teams' Cruise Reports assembled by the Chief Scientists at the end of Leg 1, Leg 2 and Leg 3 of the Amundsen Expedition carried. The 2018 Expedition Report is divided into two parts:

Part I gives an overview of the expedition, shows the cruise track and the stations visited and provides a synopsis of operations conducted during each of the four legs.

Part II contains the reports submitted by participating science teams or researchers, with details on the specific objectives of their project, the field operations conducted and methodology used, and in some cases, preliminary results. When results are presented, they show the data as they were submitted at the end of the legs in 2018. The data presented in this report are illustrative only and have not been quality checked, thus parties interested in the results should contact the project leader or the researchers who collected the data.

The sections in Part II describing each project are organized with atmospheric, surface ocean and sea ice components first (sections 1 to 4), followed by water column properties, which include the mooring programs (sections 5 and 6), CTD-Rosette operations and physical properties (sections 7 and 8), ocean optical properties and freshwater sources (sections 9 and 10) as well as a suite of chemical and biological parameters (sections 11 to 26). Contaminants cycling in seawater are treated in sections 27 to 31. The last sections cover benthos sampling (sections 32 to 36), seabed mapping (sections 38 and 38), sediments sampling (sections 39 to 43) and ROV operations (sections 44 and 45).

The four Appendices provide information about the location, date, time and type of sampling performed at each station visited by the ship, as well as a list of science participants onboard during each leg.

The core oceanographic data generated by the CTD-Rosette operations, as well as meteorological information (AAVOS) and data collected using the Moving Vessel Profiler (MVP), the ship-mounted current meter (SM-ADCP) and the thermosalinograph (TSG) are available in the Polar Data Catalogue (PDC) at www.polardata.ca.

Following ArcticNet's data policy, research teams must submit their metadata to the PDC and insure that their data are archived on the long-term, but it is not mandatory to use the PDC as a long-term archive as long as a link to the data is provided in the metadata (see www.arcticnet.ulaval.ca/Docs/data-policy for more details on data policy).

Part I – Overview and synopsis of operations

1 Overview of the 2018 *Amundsen* Expedition

1.1 Introduction

Understanding the transformation of the Arctic environment is one of the great challenges faced by Canadians and the national and international scientific communities. ArcticNet is a Network of Centres of Excellence of Canada that brings together scientists and managers in the natural, human health and social sciences with their partners from Inuit organizations, northern communities, federal and provincial agencies and the private sector to study the impacts of climate change and modernization in the coastal Canadian Arctic.

Since 2004, ArcticNet researchers have been conducting extensive multidisciplinary sampling programs in the Canadian Arctic using the Canadian research icebreaker CCGS *Amundsen*. The overarching goal of the ArcticNet marine-based research program is to study on a long-term basis how climate induced changes are impacting the marine ecosystem, contaminant transport, biogeochemical fluxes, and exchange processes across the ocean-sea ice-atmosphere interface in the Canadian Arctic Ocean. The knowledge generated from this multi-year program is being integrated into regional impact assessments to help decision makers and stakeholders develop effective adaptation strategies for the changing coastal Canadian Arctic.

The geographic scope of the ArcticNet marine-based research program (see Phase 3 projects at www.arcticnet.ulaval.ca/research/phase 3) includes the Beaufort Sea in the western Canadian Arctic, the Canadian Arctic Archipelago and Baffin Bay in the eastern Arctic, and extends into Hudson Bay, Ungava Bay and along the northern Labrador coast.

In the western Arctic, northern Baffin Bay and Hudson Bay, ArcticNet has established long-term oceanic observatories. Each observatory consists of a number of moorings equipped with instruments that gather continuous records of currents, temperature, conductivity, turbidity, dissolved oxygen and the vertical flux of carbon and contaminants. Some moorings are also equipped with autonomous hydrophones to record the acoustic background and the vocalizations of marine mammals.

On Friday 25 May 2018, the Amundsen left its homeport of Quebec City for a 128-day scientific summer expedition to the Hudson bay and the Canadian arctic in support of several research programs, including ArcticNet annual marine-based research program, BaySys, a project that aims a better understanding of variability and change of freshwater-marine coupling in the Hudson Bay System, Vulnerable Marine Ecosystem ROV Program, Sentinel North BOND, BriGHT and PhD School projects as well as fisheries and oceans Canada (DFO).

1.2 Regional settings

1.2.1 *Labrador Sea*

Between Labrador and Greenland lies the Labrador Sea, a key region that includes the Labrador Current system. This strong current carries cold water down from Baffin Bay to offshore Newfoundland and, therefore, strongly influences the oceanographic conditions on the Atlantic Canadian Shelf. The Labrador Sea acts as a corridor for southward drifting icebergs and ice islands, inducing risks for activities and operations conducted offshore Newfoundland. From this perspective, gathering scientific knowledge about the area is of particular importance as to inform federal departments and the private sector about the risks associated with the exploration and exploitation of oil and gas.

1.2.2 *Baffin Bay*

Baffin Bay is located between Baffin Island and Greenland and connects the Arctic Ocean and the Northwest Atlantic, providing an important pathway for exchange of heat, salt and other properties between these two oceans. In the south, Davis Strait, which is over 300 km wide and 1000 m deep, connects it with the Atlantic, but Baffin Bay's direct connection to the Arctic Ocean is far more restricted, consisting of three relatively narrow passages through the islands of the Canadian Arctic Archipelago (CAA).

One of these passages, Nares Strait, is located between Ellesmere Island and Greenland and includes from south to north: Smith Sound, Kane Basin, Kennedy Channel, Hall Basin and Robeson Channel. Each winter, there is a prolonged period during which land-fast ice arches span the strait at the entrance to Robeson Channel and south of Kennedy Channel. The ice in Nares Strait then becomes land-fast and shuts down southward ice motion. In the past decade, changes to this long-standing pattern of ice conditions have been observed with weaker or absent ice arches in Nares Strait resulting in increased ice flux from the Arctic and reduced amount of ice allowed to reside in the Arctic Ocean to thicken as multi-year ice.

Southern Baffin Bay supports concentrations of corals and sponges, inclusive of gorgonian and antipatharia species. A survey of the seafloor using the *Amundsen*'s remotely operated vehicle (ROV) will be conducted to explore the area, locate and sample hotspots of corals and sponges in this unique deep and cold Arctic environment.

1.2.3 *Beaufort Sea*

The Canadian Beaufort Sea/Mackenzie Shelf region of the Arctic Ocean has witnessed major changes in recent years, with decreasing sea ice cover and major shifts in sea-ice dynamics. The Beaufort Sea is characterized by a broad shelf onto which the Mackenzie River, the largest river in North America, carries large amounts of freshwater. The mixing of freshwater from the Mackenzie River and Arctic marine waters of the Beaufort Sea establishes an estuarine system over the shelf, with associated inputs of land-derived nutrients and freshwater biota. Along the Mackenzie Shelf stretches the Cape Bathurst polynya, an expanse of open water that exists

year-round and is highly productive. This ecosystem is also exceptional since it provides habitat for some of the highest densities of birds and marine mammals in the Arctic.

Since 2002, extensive multidisciplinary research programs have been conducted in the Beaufort Sea area. Major oceanographic research activities were carried out as part of two major international overwintering research programs conducted onboard the CCGS *Amundsen* in 2003-2004 (CASES program) and in 2007-2008 (CFL Study). Environmental and oceanographic research activities were also conducted in the offshore region of the Mackenzie Shelf, shelf slope and Beaufort Sea since 2009, in partnership with the Oil & Gas industry and within the framework of the Beaufort Regional Environmental Assessment (BREA, www.beaufortrea.ca) program. Overall since 2004, a marine observatory of a minimum of five oceanographic annual moorings (from 5 to 17 moorings) has been deployed and maintained annually in the area by ArcticNet researchers.

1.2.4 *Hudson Bay*

Hudson Bay is a virtually landlocked, immense inland sea that possesses unique characteristics among the world's oceans: a limited connection with the Arctic and Atlantic Oceans, a low salinity, a high volume of freshwater inputs from numerous rivers that drain central North America, a winter season in which it is completely ice covered while summer is characterized by ice-free conditions. In Hudson Bay, operations were conducted within the framework of the BaySys/ArcticNet mooring program that aimed to understand the variability and change of freshwater-marine coupling in the Hudson Bay System.

1.3 2018 Expedition Plan

1.3.1 *General schedule*

Based on the scientific objectives, the summer expedition was divided into three separate legs. Leg 1, from 25 May to 5 July, took the Amundsen into the Hudson Bay and included transit and sampling activities in Hudson Strait. Leg 2, divided in three shorter legs: 2a, 2b and 2c, took the ship from Hudson Bay to The Labrador Sea, Baffin Bay and Baffin Island's coast. During Leg 3, the ship headed back towards Quebec City, but not before conducting sampling activities in the Beaufort Sea, in Baffin Bay and close to Baffin Island's coast.

1.3.2 *Leg 1 – BaySys - 25 May to 5 July 2018 – Hudson Bay*

The Amundsen Science 2018 Summer Expedition started on 25 May for a six-week leg dedicated to BaySys research project. Focused on understanding the relative contributions of climate change and regulation on the Hudson Bay system, Leg 1 involved, predominantly, water column sampling and ice sampling activities throughout the Hudson Bay and Hudson Strait. Science activities also included four mooring deployments, three mooring recoveries and one wave buoy deployment. The end of Leg 1 brought the ship to Churchill where the community

was welcomed on board for a tour of our scientific installations and lunch and cookies in the officer's mess.

1.3.3 *Leg 2a – Sentinel North BriGHT / BaySys - 5 July to 13 July 2018 – Hudson Bay*

Following the full crew change in Churchill, Leg 2a led the ship east of Hudson Bay to conduct water column sampling activities on behalf of the Sentinel North BriGHT project. This one-week leg also gave the opportunity to BaySys teams to extend their data area by joining Sentinel North sampling efforts. After a week of CTD-Rosette, nets and trawls deployments, the ship reached Iqaluit for a science rotation and the end of Leg 2a.

1.3.4 *Leg 2b – Sentinel North PhD School & BOND - 13 July to 24 July 2018- Baffin Bay, Baffin Island Coast and Labrador Sea*

Leg 2 carried on with two Sentinel North projects: the PhD School and the BOND project. Those two projects brought the ship to the Labrador Sea, to Baffin Bay and to Baffin Island's coast, for 10 days of ice and water column sampling. As scientists focused on the lab and deck operations, students assisted to lectures and got hands-on training by helping with the different sampling activities. Leg 2b was also a unique opportunity to survey Coronation Fiord's seabed. The leg ended on 24 July in Iqaluit with a science rotation.

1.3.5 *Leg 2c – Vulnerable Marine Ecosystem ROV Program / DFO / ArcticNet Frobisher & HiBio - 24 July to 16 August 2018- Baffin Bay, Baffin Island Coast and Labrador Sea*

After the science rotation in Iqaluit, the scientist and crew went back to work for a three-week leg of oceanographic sampling. Amongst the science operations conducted, 11 ROV dives allowed the collection of precious data on the Arctic benthos. Leg 2c also permitted 13 deployments of the surface microplastic trawl in order to characterize the microplastic contamination of the Arctic waters, the deployment of two moorings and the recovery of one mooring. This fruitful leg ended on 16 August as the ship reached Resolute for a full crew change.

1.3.6 *Leg 3 – Kitikmeot Marine Ecosystems Study / ArcticNet - 16 August to 9 September 2018- Baffin Bay, Baffin Island Coast and Beaufort Sea*

The Amundsen pursued its summer expedition for another three weeks of water column and geologic sampling activities. Dedicated to Kitikmeot Marine ecosystems study and ArcticNet program, Leg 3 involved CTD-rosette, nets and trawls deployments, but also many corer deployments, such as box corer, piston corer and gravity corer. The leg and the 2018 summer expedition ended with the ship making its way back to its homeport in Quebec City, accosting on 9 September.

2 Leg 1– 25 May to 5 July 2018 – Hudson Bay and Hudson Strait

Chief Scientist: David Barber[1] (david.barber@umanitoba.ca)
1 Centre for Earth Observation Science, University of Manitoba, Wallace Building, 125 Dysart Rd, Winnipeg, MB, R3T 2N2, Canada.

2.1 Introduction

Starting on 25 May in Quebec City and ending on 5 July in Churchill, Leg 1 was dedicated to the BaySys project. The overarching goal of BaySys is to understand the relative contributions of climate change and regulation on the Hudson Bay system. To do so, five research teams investigated the following interconnected subsystems of the Hudson Bay:

- Marine/Climate Systems
- Freshwater
- Marine Ecosystem
- Carbon Cycling
  Contaminants

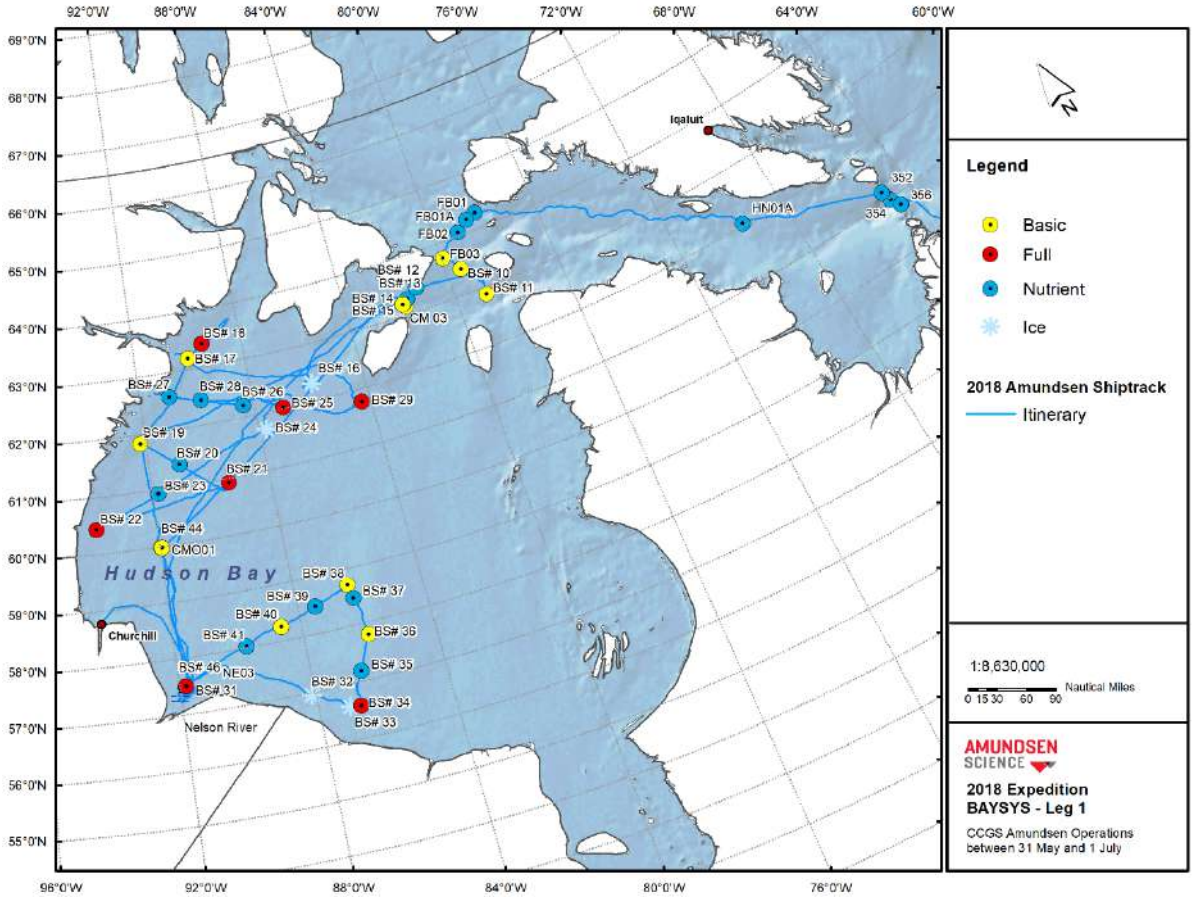

Figure 2-1 Ship track and location of stations sampled by the CCGS Amundsen in support of BaySys program in the Hudson Bay during Leg 1 of the 2018 Expedition

2.2 Synopsis of operations

This section provides a general synopsis and timeline of operations during Leg 1. Detailed cruise reports provided by onboard participants and including specific objectives, methodology and preliminary results for projects conducted during this leg are available in Part II of this report.

During this leg, the *Amundsen* traveled from Quebec City, QC (25 May) to Churchill, MB (5 july). 45 stations were completed onboard the CCGS *Amundsen* and 78 remote stations were completed (Table 3.1) with an overall tally of deck operations as follows:

- 65 CTD-Rosette casts
- 37 box cores sampling of the sediments
- 16 ice sampling operations
- 25 Agassiz trawl deployments and14 beam trawl deployments
- 9 PNF deployments
- 21 monster net deployments, 11 tucker net deployments, 6 Hydrobios deployment and 1 vertical net deployment
- 3 mooring recoveries and 4 mooring deployments
- 6 MVP profiles
- 44 Optics sensors deployments
- 18 'bucket' water sampling operations
- 1 wave buoy deployment and recovery

A detailed scientific log for all sampling operations conducted during Leg 1 with the positions and depths of the visited stations is available in Appendices 1 and 2.

Table 3-1 List of all station types and number of times each were completed during Leg 1

Amundsen Station Type	Number of station
Nutrient	20
Basic	9
Full	14
Other*	02
Total	45
Remote Station Type**	
Helicopter	54
Zodiac & Barge	24
Total	78
Total Stations Conducted	123

* Opportunistic ice grab and single mooring turnovers with no other operations associated with the station ID
** All remote sea ice & landfast ice sampling, and open water and river sampling. Does NOT include ice sampling as part of Full Station Amundsen ice cage operations

2.2.1 *Station Type Definitions*

Nutrient

- Station with 1 Rosette Cast for nutrient sampling
- Sometimes included 1 or 2 additional deck operations if time permitted (ex., Niskin bottle sampling; vertical or horizontal nets etc.)

Basic

- Station with open water-based sampling operations
    - 2 Rosettes
    - Horizontal Nets
    - Vertical Nets
    - Beam Trawls
    - Agassiz Trawls
    - Box Cores
    - Optical Instrument Suite
- Some ice operations were conducted when and where possible (if nearby ice floes were present).

Full

- Station with all sampling operations including open water, ice, and remote.
    - 2 Rosettes
    - On-ice Operations via Cage
    - Skippy Boat/Zodiac Operations
    - Helicopter Survey and Sampling Operations
    - Vertical Nets
    - Horizontal Nets
    - Beam Trawl
    - Agassiz Trawl
    - Box Cores
    - Optical Instrument Suite

2.2.2 *Timeline of operations*

Week 1 of the cruise was predominately dedicated to transiting from the Quebec City port to the Hudson Strait via the Labrador coast. The transit took roughly 6 days and included a 7-hour Search and Rescue (SAR) call on 30 May 2018. During the first 2 days of this transit, we completed Amundsen familiarization and safety tours on board and emergency alarm and procedures were tested. In addition, safe operations meetings for scientists and Amundsen crew were organized and held during the first week of the cruise. This included safety meetings for sea-ice work, river work, helicopter safety and operations, optical instrument operations, rosette operations, mooring operations, and general water sampling operations. Individual toolbox meetings were held prior to the start of each operation beginning on day 6, and the skippy boat – used for on-ice operations – was also briefly tested during this time. During the first week of Leg 1, general science meetings were scheduled each evening as time allowed for a research presentation from six scientists/students.

The Amundsen crew and scientists shifted to a 24-hour work schedule starting on 31 May, and continued on this schedule until the final week of operations. Our first stations were conducted on 31 May, along the entrance into the Hudson Strait from the Labrador coast. With a need to make up time entering Hudson Bay the number of stations conducted along the strait was reduced to four. After the completion of those four stations, we began extensive operations across the entrances leading into the Bay (i.e., areas surrounding Baffin, Southampton, Coats, and Mansel Island), and used helicopter operations for remote ice stations in areas of heavy ice concentration. Remote operations allowed for a more expansive sampling coverage. On 5 June, we successfully deployed our first mooring (CMO03) just north of Coates Island. By 6 June, we had entered into Hudson Bay for the first stations within open bay ice. At station 16, three remote short-term ice GPS instruments were deployed with the intent to be recovered later in the campaign. Prior to our 7 June community visit off the shore of Chesterfield Inlet (see below for more details of the onboard visit), we conducted the first of three MVP transects along the west coast of Hudson Bay, providing a continuous profile of sea temperature, salinity, and depth, among other measurements.

Week 3 was used to sample between the coast and the westernmost ice edge of central Hudson Bay, by which time was located approximately 100 nautical miles from the coast. Two additional MVP transect lines were completed from the coast into the open water, and five river systems were successfully sampled for water via helicopter (i.e., Chesterfield; Wilson; Ferguson; Tha-anne; Thlewiaza). Land fast ice was sampled along the coast of Chesterfield Inlet, along with the Wilson and Ferguson river mouths. During river operations, intensive drone surveys of the coastlines were conducted. In addition, photo surveys of the sea ice edge were completed via the helicopter. The zodiac was made useful along this coast as two multi-stations transects were conducted starting at the edge of the landfast ice of the Wilson and Thlewiaza Rivers, respectively, and systematically sampling out into the open water towards the Amundsen's position (Figure 3.1). From each of these major river regions, we positioned stations strategically out from the coast and into the ice edge of the Hudson Bay with intermediate stations in between to provide information across the entire water column from shoreline to sea-ice. Prior to the science rotation in Rankin Inlet, we located and recovered the short-term ice station instruments near station 16 (Figure 3.1). On 14 June, we arrived at Rankin Inlet for a partial scientist crew change, in addition to a Capitan change due to unfortunate circumstances and family emergency requiring Claude LaFrance to depart. Alain Gariépy came on board as captain for the remaining two weeks of Leg 1.

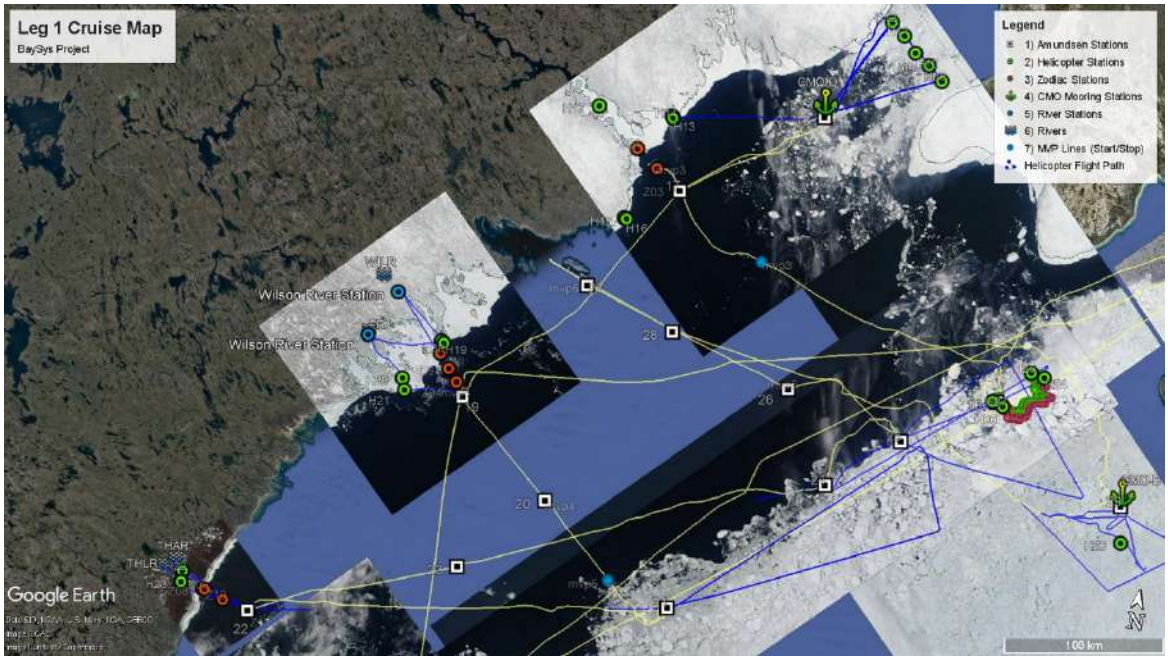

Figure 2-2 Western Hudson Bay cruise track with all stations and remote tracks included. MODIS imagery overlay from 8 June – 14 June 2018

Week 4 of Leg 1 brought significant changes to the overall cruise plan. The original plan to transit directly across the bay (scheduled for 4 days) to sample the East coast and rivers was impeded by heavy concentrations of sea ice remaining in this region. Therefore, we were unlikely able to successfully cross the bay in the proposed amount of time. After a 2-day transit, we managed to arrive at the third CMO mooring station (Stn. 29) in the north-central region of the bay. After the successful deployment of mooring CMO-B, we were called to respond to a second SAR near Whale Cove, on the west coast of the bay. This SAR call was completed in 1 day. After the call, a decision was made to head south on a direct route towards the Nelson Estuary, and from there, to follow the southern coast of the bay towards the East. During this transit, we stopped at the site of mooring AN01, but determined that the ice cover remained too high to recover it at that time. Once arriving at the Nelson Estuary on 18 June, the mooring NE02 was recovered and a nearby station was completed along with the sampling of both the Nelson and Hayes Rivers via helicopter. Navigating the southern coast proved once more to be more difficult than anticipated. Large, thick, and sediment-laden freshwater ice floes considerably slowed the Amundsen's progress. During this time, however, we sampled two stations in the ice edge, and both the Severn, and Winisk Rivers via helicopter. While in this region, the decision to deploy 10 ice beacons was made to track the movement of the ice pack and gain insight into the possible double gyre current in the bay. By the conclusion of week 4, we had completed a total of 34 stations, and needed to come up with a new plan to return to the Nelson as we were nearing the end of our time on Leg 1.

Week 5, the decision was made to travel north into the ice pack towards deeper water in central Hudson Bay. We transited about 150 nautical miles north and conducted stations along a route north from the southern coast. Once the ice conditions worsened, becoming an impediment, we

began our transect back southwest towards the Nelson Estuary. Following our arrival in the Nelson Estuary, we deployed a wave buoy in conjunction with an ADCP mooring (25 June). Shortly after the start of our next station operation, we were called off for our third SAR. This time, at the northernmost part of the bay, just off the coast of Cape Dorset. This SAR response lasted 2.6 days. Following the completion of the call – and our new position north of Coates Island – a decision was made to resample station 15, this time without ice cover. During our transit back towards the Nelson, we recovered the AN01 mooring just north of Churchill, and deployed the CMO-A mooring nearby. In addition to this deployment, we were able to sample the Seal, Knife, and Churchill Rivers all via helicopter.

Three additional days were spent in the Nelson Estuary (29 June – 1 July) conducting intensive sampling by zodiac, barge, and helicopter. The winds were high, making it difficult to manage all the operations on board smaller vessels, however, seven stations along the Nelson River transect could be sampled, three stations along the south transect from the coast to the position of the Amundsen, and three stations along a modified western coast transect using Rosette casts and bucket sampling from the Amundsen. In addition, onboard operations were conducted at two locations within the estuary (i.e., stn. 45-46). On 29 June, the helicopter was used to conduct a large scale gridded photo survey of the estuary with the aim to locate beluga pods, and plumes exiting the river systems. The following day during low tide, the helicopter landed on the coastal mud flats in order for our crew to collect sediment samples. The wave buoy and ADCP mooring deployed a few days earlier were recovered prior to leaving the area on 1 July, and heading north towards Churchill to arrive at the port by 2 July. Upon arrival in Churchill we hosted a large community visit on board (~ 150 people), and held the Knowledge Exchange Workshop. On 5 July a full crew change was completed, ending Leg 1.

Figure 2-3 Nelson Estuary cruise track with all stations and remote tracks included. MODIS imagery overlay from June 18th 2018

2.3 Community Visits

2.3.1 *Chesterfield Inlet Community Visit*

On 7 June, the Amundsen anchored offshore, and hosted a community visit with Chesterfield Inlet population. We brought 17 members of the community over to the ship via helicopter, including Mayor Simionie Sammurtok, HTO council members, and younger high school graduates interested in ocean sciences. Overall, the visit went very well. After arriving, they were brought on a tour of the ship, which included seven science stations highlighting some of the many different operations and labs on board. These stations included a visit to the Rosette deployment area and data rooms to learn about oceanography and water sampling. The sea-ice team discuss their operations along with the radiometer, and the benthos and sediment labs were used to showcase and discuss some of the many diverse organisms that have been collected throughout the Bay. The aft labs were used to discuss oil contaminants and optical instruments, and on the foredeck, water chemistry was discussed. Lastly, the community guests were taken to the 600 deck labs to learn about food web sciences, including phytoplankton, nutrient, fish larvae, and adult fish. Following the tour, the members of Chester were invited inside for lunch in the Officer's mess, followed by a brief presentation detailing the BaySys project and what it is that we hope to accomplish in Hudson Bay going forward. This presentation was followed by a discussion with the community on what their experiences and the changes they see on the bay each year, including the reduction in the local goose and large beluga populations.

Some of the fishermen also noted catching certain species of fish that are rarely seen in this part of the bay.

2.3.2 *Churchill Community Visit and Knowledge Exchange Workshop*

The Churchill community visit took place throughout the morning of Tuesday, 3 July. For two hours, the Amundsen hosted over 100 community members excited to visit the ship. They were provide time for a self-guided tour of the exterior work stations and instruments, along with the wheelhouse. The community visitors were able to experience the excitement of being on board the large icebreaker and were given an opportunity to discuss and ask questions to our science teams situated at stations throughout the ship.

The Knowledge Exchange Workshop event took place in Churchill, MB over two days, which included a zodiac-based beluga tour, and a community-hosted wine and cheese reception on 2 July followed by a full day tour, workshop, and discussion panel onboard the Amundsen on 3 July. The workshop was co-hosted by the Honourable Jim Carr, Minister of Natural Resources and Dr. Digvir Jayas, Vice President Research and International, University of Manitoba.

The workshop event was well attended (~40) by dignitaries and invited guests from across the country. It was about discussing ways to communicate across the various stakeholders in the Arctic, and to showcase the different perspectives from science, policy and Indigenous groups. The aim for the event was to open up communication channels, and allow for greater understanding of both the challenges and opportunities that we are facing in the Arctic.

The workshop included discussions with researchers and students working onboard the CCGS *Amundsen*. Several keynote presentations were delivered both in the Town of Churchill and onboard the CCGS *Amundsen*. A discussion panel focused on the topic “Climate Change, Industrialization and Globalization: Are we prepared for both the challenges and opportunities?” included representatives from the Inuit Circumpolar Council, the community of Chesterfield Inlet, the Canadian Coast Guard, Fisheries and Oceans Canada and the University of Manitoba. Many of the questions focused on how we can move forward to bring the knowledge gained from science and mobilize it into policy.

2.4 Chief Scientist’s comments

Leg 1 of the 2018 Amundsen cruise was a successful endeavour. Many of our objectives for the cruise and BaySys project were achieved, minus a few locations in which we were not able to access due to ice and weather conditions. Overall, data collection and sampling went exceptionally well, including all on board and remote-based (i.e., helicopter; zodiac; barge; and on-ice) operations

3 Leg 2a – 5 July to 13 July 2018 – Hudson Bay and Hudson Strait

Chief Scientist: Jean-Éric Tremblay[1] (Jean-Eric.Tremblay@bio.ulaval.ca)
[1] *Université Laval, Département de biologie, Pavillon Alexandre-Vachon, 1045 avenue de la Médecine, Québec, QC, G1V 0A6, Canada.*

3.1 Introduction

Leg 2a took place from 5 July to 13 July 2018 and focused on achieving Sentinel North BriGHT project objectives. This Sentinel North thematic project focus on bridging global change, Inuit health and the transforming Arctic Ocean.

During Leg 2a, the research efforts were concentrated in the Hudson Bay and in the Hudson Strait (Figure 3-1).

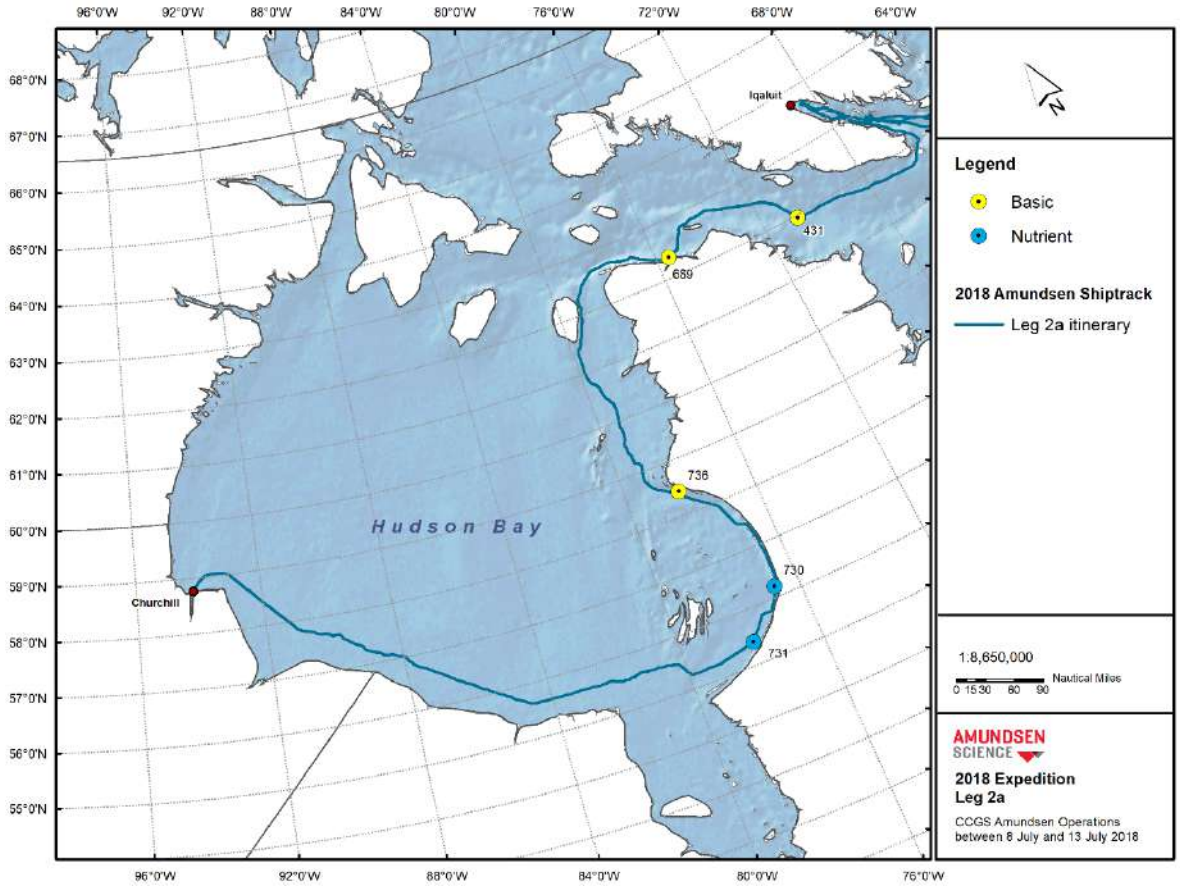

Figure 3-1 Ship track and location of stations sampled by the CCGS Amundsen in support of Sentinel North BriGHT project in the Hudson Bay during Leg 2a of the 2018 Expedition

Specific objectives and priorities of Leg 2a were to:

- Conduct oceanographic sampling in the Hudson Bay;

- Conduct nets and trawls deployment in the Hudson Bay;
- Conduct opportunistic helicopter flights to collect water in selected rivers;
- Conduct opportunistic beam trawl deployment at Basic stations or in-between;
- Conduct opportunistic box core deployment at selected Basic stations.

3.2 Synopsis of operations

This section provides a general synopsis and timeline of operations during Leg 2a. Detailed cruise reports provided by onboard participants and including specific objectives, methodology and preliminary results for projects conducted during this leg are available in Part II of this report.

During this leg, the *Amundsen* traveled from Churchill (5 July) to Iqaluit (13 July) and 5 stations were visited with an overall tally of operations and activities as follows:

- 6 CTD-Rosette casts
- 3 Agassiz trawl deployments
- 3 Monster net deployments and 6 tucker net deployments
- 2 PNF deployments and 1 Secchi disk deployment
- 1 'bucket' water sampling operation

A detailed scientific log for all sampling operations conducted during Leg 2a with the positions and depths of the visited stations is available in Appendices 1 and 2.

3.2.1 *Timeline of operations*

The ship left Churchill after a full crew change on 5 July. The following three days were spent breaking ice towards the Hudson Bay east coast's first station (731), which was reached on 8 July. This short nutrient station (1 Rosette cast and 1 Secchi disk deployment) was completed in the early afternoon allowing the completion of another nutrient station (730) before nightfall. The night was spent transiting North, off the coast of Inukjuak, to reach the first basic station (736) of leg 2a. The morning of 9 July was entirely dedicated to station 736 with tucker Net, Monster Net, PNF and CTD-Rosette deployments along with Zodiac operations.

The CCGS *Amundsen* then spent two days sailing towards Sugluk Inlet, where basic station 689 was completed by the early morning of 12 July. The same day, the crew and scientists conducted a second basic station (341) in the water of the Hudson Strait. Science activities there consisted in two CTD-Rosette, two tucker net, one monster net and one Agassiz trawl deployments and were wrapped up just in time for dinner.

On 13 July, the ship reached Iqaluit for a science rotation and the end of Leg 2a.

4 Leg 2b – 13 July to 24 July 2018 – Baffin Bay, Baffin Island Coast and Labrador Sea

Chief Scientist: Marcel Babin[1] (marcel.babin@takuvik.ulaval.ca)
[1] *Département de biologie, Université Laval, 1045 avenue de la Médecine, Québec, QC, Canada*

4.1 Introduction

Leg 2b started and ended in Iqaluit, from 13 July to 24 July. Dedicated to the PhD School and the BOND project of Sentinel North's program, Leg 2b led the ship to Baffin Bay, to Baffin Island's coast and to Labrador Sea (Figure 4-1).

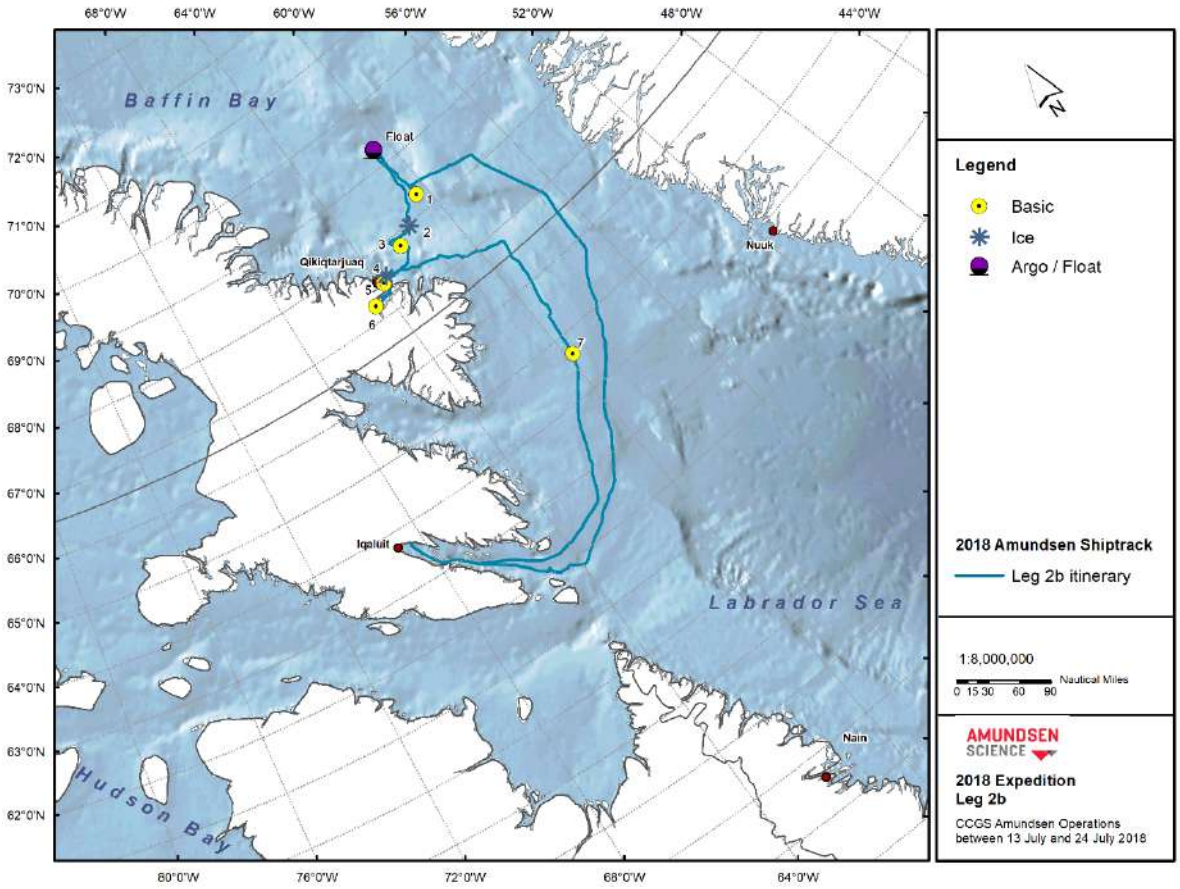

Figure 4-1 Ship track and location of stations sampled by the CCGS Amundsen in support of Sentinel North PhD School and BOND projects in the Baffin Bay during Leg 2b of the 2018 Expedition

Specific objectives and priorities of Leg 2b were to:

- Provide high-quality lectures and hands-on training to Schools on Board Program participants;
- Conduct oceanographic sampling operations;

- Conduct a 24-hour study of the maximal plankton bloom, including zooplankton dial vertical migrations with Hydrobios deployment (every 3 hours) and CTD-Rosette profiles;
- Deploy 2 Pro-Ice floats with a 1000m depth CTD-Rosette cast.

4.2 Synopsis of operations

This section provides a general synopsis and timeline of operations during Leg 2b. Detailed cruise reports provided by onboard participants and including specific objectives, methodology and preliminary results for projects conducted during this leg are available in Part II of this report. During this leg, the *Amundsen* traveled from Iqaluit (13 July) to Iqaluit (24 July) and 8 stations were visited with an overall tally of operations and activities as follows:

- 7 CTD-Rosette casts
- 4 Acoustic sensor deployments
- 3 Argo float deployments
- 5 Ice sampling operations
- 6 Monster net deployments
- 8 PNF deployments

A detailed scientific log for all sampling operations conducted during Leg 2b with the positions and depths of the visited stations is available in Appendices 1 and 2.

4.2.1 *Timeline of Operations*

While the ship left Iqaluit on 13 July, science activities only started on 15 July with lectures about game-changing technologies presented to the PhD school participants. They were introduced to powerful artificial intelligence tools, remote sensing and autonomous platforms. An ARGO float was shown and described in detail. This was also the day where the participants crossed the 66° parallel with excitement and enthusiasm.

The next day started early with an ARGO floats successful recovery in Davis Strait. Station 1 was then reached and scientific operations allowed the PhD school participants, divided into six work groups, to investigate different parts of the arctic ecosystem and the physical properties of its water. All operations were completed before dinner and student teams could enjoy some free time.

17 July was dedicated to station 2 deck, barge and ice operations. Two Argo floats were also deployed that day. The next day, 18 July, scientists woke up surrounded by ice, and rumours of one lone polar bear somewhere on the horizon. After the excitement of seeing their first polar bear, student teams used the whole day for station 3 and all the deck, barge and ice operations it implied. The science meeting held that night was under the form of a group discussion about working in the North with local communities. There were many interesting experiences shared and it got all students looking forward to their interaction with the people of Qikiqtarjuaq over the next couple of days.

On 19 July, crew and scientists had the chance to receive some special guests. Nine members of the Qikiqtarjuaq community joined them on board for a tour of the ship. During the day, the guests went around the boat to see all the scientific instruments. It was also a chance to have a glimpse on the crew's day-to-day life on the boat. While the visitors were on board, some mentors and students had the chance to go on the barge to deploy a glider and a CTD-Rosette was deployed from the ship. The next day, around 60 people amongst the ship went to Qikiqtarjuaq to visit the community of 600 peoples in which half are children. The day started around 10 o'clock at the Gathering center, where William and Alisha greeted them and invited them to visit the museum to learn about the local culture. After this cultural activity a feast was waiting for them, to allow them to have a taste of polar bear meat, raw and cooked seal, dry arctic char and *bannick* (yeast-less bread). People went back on the ship, rich on their experience and encounters of the day. The simplicity of the people living in Qikitarjuaq was really appreciated despite the difficulties that some people are experiencing living in a remote community, including health issues in the aftermath of the tuberculosis outbreak and food security due to climate and social changes.

Back to science the next day, station 4 was completed before noon, leaving the rest of the day to transit towards Coronation fjord for seabed mapping and station 6. The student had acquired a nice pace by then and completed station 6 in less than 4 hours the next day.

23 July was the last day of science onboard the Amundsen for the student of Sentinel North's PhD school. The last day involved data processing for each work package, preparing presentations and deploying one last Argo float.

The ship reached Iqaluit by 24 July and a science rotation left students and mentors on the ground with a thankful feeling and tons of new knowledge to share.

4.3 Chief Scientist's comments

As useful, the crew was very helpful and professional. During this leg, we deployed a glider and could not recover it before the end of the leg, despite major efforts to find it. Fortunately, it was found by one member of the Qikiqtarjuaq community one day after our departure from the zone. The glider was later (end of August) recovered by the Amundsen crew in Qikiqtarjuaq.

5 Leg 2c – 24 July to 16 August 2018 – Baffin Bay, Baffin Island Coast and Labrador Sea

Chief Scientist: Philippe Archambault[1] (philippe.archambault@bio.ulaval.ca)
[1] Laboratoire d'écologie benthique, Université Laval, Pavillon Alexandre Vachon 1045 avenue de la Médecine (Québec)

5.1 Introduction

Leg 2c of the 2018 Amundsen Expedition took place from 24 July to 16 August and was centered on the Vulnerable Marine Ecosystem ROV Program and the ArcticNet Program along with a collaboration with Fisheries and Oceans Canada (DFO). This ambitious leg involved activities in Baffin Bay, along Baffin Island's coast and in the Labrador Sea (Figure 5-1).

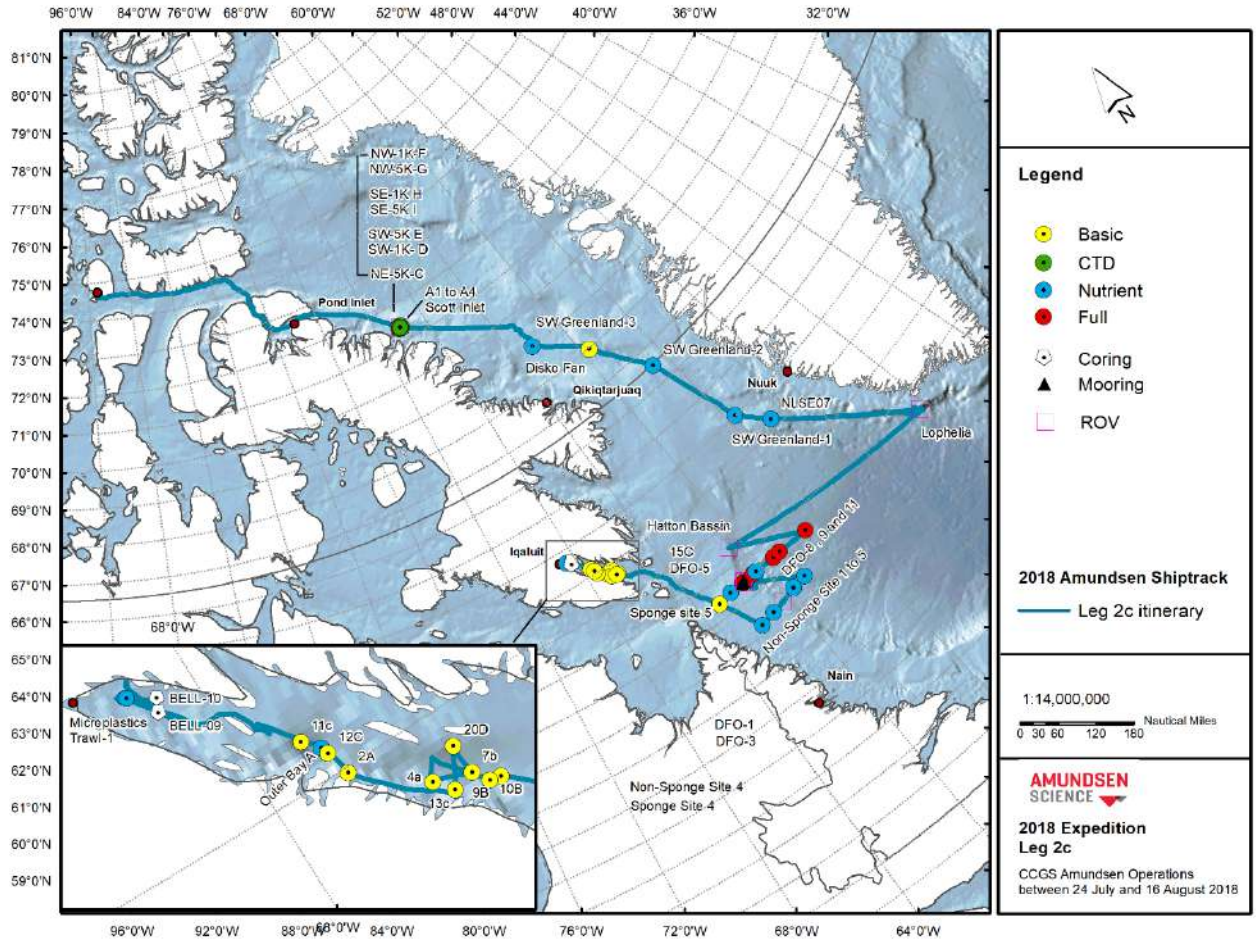

Figure 5-1 Ship track and location of stations sampled by the CCGS Amundsen in support of the Vulnerable Marine Ecosystem ROV Program and the ArcticNet Program in the Labrador Sea and in Baffin Bay during Leg 2c of the 2018 Expedition

Specific objectives and priorities of Leg 2c were to:

- Conduct oceanographic sampling and habitat mapping in Inner and Outer Frobisher Bay and along the transect in southern Baffin Bay (DFO);
- Conduct 9 ROV dives;
- Deploy 1 mooring (HiBio-B-2018), re-deploy 1 mooring (HiBio-A-2018), recover 1 mooring (HiBio-A-2017) and deploy 1 benthic lander;
- Conduct opportunistic deployment of gravity core at nutrient stations NLSE03 and SW Greenland-1;
- Conduct opportunistic helicopter flights for river geochemical sampling during transit through Lancaster Sound to Resolute Bay.

5.2 Synopsis of operations

This section provides a general synopsis and timeline of operations during Leg 2c. Detailed cruise reports provided by onboard participants and including specific objectives, methodology and preliminary results for projects conducted during this leg are available in Part II of this report. During this leg, the *Amundsen* traveled from Iqaluit (24 July) to Resolute Bay (16 August) and 54 stations were visited with an overall tally of operations and activities as follows:

- 47 CTD-Rosette casts
- 18 Box cores and 5 gravity cores
- 5 Agassiz trawl deployments and 13 surface microplastic trawl deployments
- 19 Drop camera deployments
- 15 Phytoplankton net deployments, 8 WBAT deployments, 2 monster net deployments, 6 IKMT deployments and 9 hydrobios deployments
- 1 Argo float deployment
- 3 Lander deployments
- 2 Mooring deployments and 1 mooring recovery
- 11 ROV deployment

A detailed scientific log for all sampling operations conducted during Leg 2c with the positions and depths of the visited stations is available in Appendices 1 and 2.

5.2.1 *Timeline of Operations*

The ship departed Iqaluit on 24 July and reached the first station of Leg 2c (BELL-09) in the night between the 24 and 25 July. This short coring station was followed by another one, BELL-10. At both stations, a box core was successfully deployed. This busy night kept on with the completion of station «Microplastics Trawl-1» which consisted in one CTD-Rosette and four surface microplastics trawl deployments. By dinner the same day, three more stations were completed (11c, Outer Bay A and 12c), announcing a productive and promising leg.

26 July was another busy day onboard the Amundsen with the completion of seven basic stations (2A, 13C,20D, 7b,4a, 9b and 10b). Those stations involved many deck operations such as CTD-Rosette, Box core, Agassiz trawl, drop camera and surface microplastics trawl

deployments. The series of basic station got completed in the early morning of 27 July with station 15C. The ship then sailed for a few hours towards station «Sponge Site 5» where a CTD-Rosette was deployed.

28 July was dedicated to the ROV dive of «Non-Sponge Site 3». After a four-hour dive, the drop camera was deployed for a one-hour survey. A similar scenario occupied the next day as a two-hour dive at site «Saglek bank» was completed along with CTD-Rosette deployments. A full station (DFO-1) was also completed before midnight that day.

After a short transit, crew and scientists went back to work on 30 July with a nutrient station (Sponge Site 4), a ROV station (Sponge Site 3) involving 1 ROV dive and 2 lander deployments and a full station (DFO-3) involving many deck operations such as nets, rosette, drop camera and box core deployments. The next day, another full station, station DFO-750, was completed along with a mooring recovery (HiBio-A-2017). Hard work kept going on 1 August with an early morning of science operations at station 18-DFO-RIDGE consisting of three drop camera deployments. A mooring deployment followed at station DFO-3 and operations carried on in the afternoon with a ROV dive at station DFO-750. The same day, after dinner, full station DFO-5 was reached and operations there begun with CTD-Rosette, nets and Hydrobios deployments. DFO-5 got completed the next morning right before the deployment of mooring HiBio-B 2018. The rest of that day was dedicated to Nutrient station «(DFO-7) Sponge site 2».

On 3 August, 2 full stations (DFO-8 and DFO-9) got completed by the tireless team of Leg 2c! Operations ended late that day and started again in the early morning of 4 August with another full station, station DFO-11. The next day, a ROV dive was successfully conducted in Hatton Bassin and ended before lunch, leaving a full afternoon of rest for the scientists.

Work started over in the late afternoon of 6 August at the ROV station «Lophelia». There, three surface microplastic trawl deployments were conducted along with nets deployments, CTD-Rosette deployments, drop camera deployment and, of course, ROV dives. Last operation in Lophelia ended at lunch time on 8 August and was followed by a 22-hour transit.

On 9 August, the ship reached station NLSE07 and a Net deployment along with a CTD-Rosette deployment were conducted. Nutrient station SW Greenland-1 was completed the same afternoon. The next day, a third nutrient station in a row was completed (SW Greenland-2) followed by a Basic station, station «Disco Fan». Five gravity cores were deployed there along with a Box core and an Argo float.

The Greenland line was completed on 11 August with the completion of station SW Greenland-3. The next morning, the ship reached Scott inlet and two ROV dives were successfully conducted. The same day, four more stations were completed (0 time1 A1, SW-5k E, SW-1K D and 0 time 2 A2)

13 August marked Leg 2c last day of science operations. During that day, seven CTD stations were completed (NW-5k G, NW-1k F, 0 time 3 A3, SE-5K I, SE-1K H, NE-5K C and 0 time 4 A4) as well as a ROV station (NE-5k C).

6 Leg 3 – 16 August to 9 September 2018 – Baffin Bay, Baffin Island Coast and Queen Maud Gulf

Chief Scientist: Alexandre Forest[1] (Alexandre.Forest@as.ulaval.ca)
[1] *Amundsen Science, Université Laval, 1045 avenue de la Médecine, Québec, QC, Canada*

6.1 Introduction

Leg 3 started in Resolute Bay on 16 August and ended in Quebec City on 9 September (Figure 6-1). This segment of the 2018 *Amundsen* Expedition focused on the Kitikmeot Marine Ecosystems Study and ArcticNet marine program.

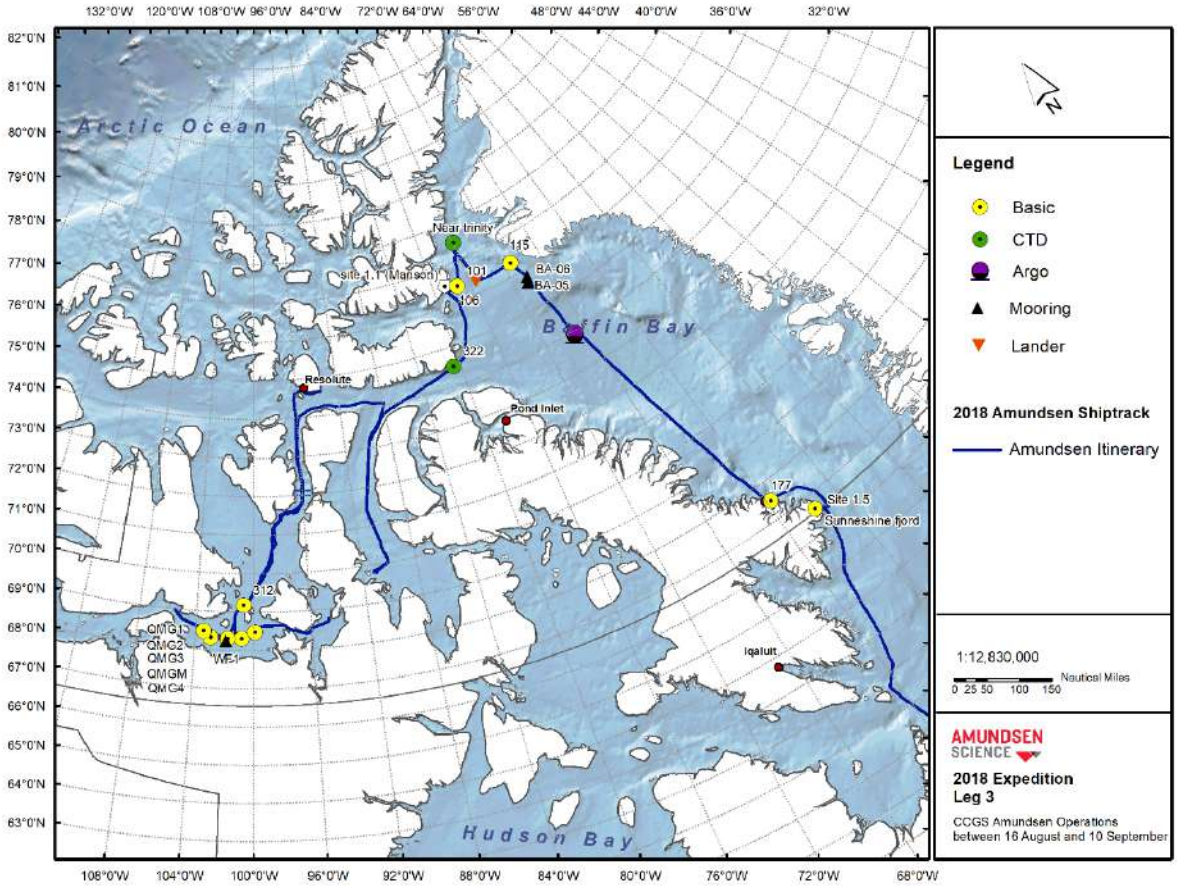

Figure 6-1 Ship track and location of stations sampled by the CCGS Amundsen in support of the Kitikmeot Marine Ecosystems Study and the ArcticNet Program in Queen Maud Gulf and in the Baffin Bay and the Beaufort Sea during Leg 3 of the 2018 Expedition

The specific objectives of Leg 3 were to:

- Recover mooring WF1-17 in Queen Maud Gulf;

- Conduct oceanographic sampling in Queen Maud Gulf, Victoria Strait, Lancaster Sound, Davis Strait and along the NOW transect;
- Conduct coring operations on SE Ellesmere Island.
- Conduct dedicated multibeam and sub-bottom seafloor surveys along SE Ellesmere Island and in Talbot Inlet / Trinity Fiord.
- Conduct glacier, oceanographic and mooring operations at Trinity & Wykeham Glacier
- Recover the benthic Lander at Station 106 and moorings BA05-17 and BA06-17 in northern Baffin Bay;
- Conduct deep high resolution CTD-Rosette profiles with collection of deep water for Ra isotopes;
- Conduct ice island operations near Qikiqtarjuaq (PII-A-1-f).

6.2 Synopsis of operations

This section provides a general synopsis and timeline of operations during Leg 3 (Table 7-1). Detailed cruise reports provided by onboard participants and including specific objectives, methodology and preliminary results for projects conducted during this leg are available in Part II of this report. During this leg, the *Amundsen* travelled from Resolute Bay (16 August) to Quebec City (9 September). In total, 20 stations were visited with an overall tally of operations and activities as follows:

- 17 CTD-Rosette casts;
- 9 Agassiz trawl deployments and 3 beam trawl deployments;
- 10 box cores, 2 gravity cores and 2 piston cores;
- 9 vertical quadruple zooplankton net (Monster) deployments and 9 oblique tucker net deployments;
- 3 mooring recoveries;
- 5 Secchi disk deployments.
- 8 ice-tracking beacon deployments
- 3 glacier surveys

A detailed scientific log for all sampling operations conducted during Leg 3a with the positions and depths of the visited stations is available in Appendices 1 and 2.

6.2.1 *Timeline of Operations*

Leg 3 started in Resolute Bay on 16 August with a full crew change. After a 24-h standby time, waiting for remaining cargo in Resolute Bay, the ship started its transit towards Queen Maud Gulf (QMG) for the Kitikmeot Marine Ecosystems Study.

On the way south, a scientist team boarded the helicopter for river sampling operations at River in Lefeuvre while other scientists and the crew kept busy onboard with safe work instructions (SWI) meetings reviewing the different deck operations, ancillary operations (e.g. ice island and iceberg survey), as well as to establish a water budget for CTD-rosette sampling. Heavy ice conditions (9+/10) were encountered in Peel Sound and Victoria Strait on the way south, slowing

down the progress of the vessel on its way towards QMG. During the transit, additional river sampling took place on Boothia Peninsula using the helicopter.

The first oceanographic station of Leg 3 (St. 312) was reached by the morning of 19 August, where science operations started with Secchi disk, rosette and net deployments, followed by box coring operations and an Agassiz trawl deployment. Operations were planned as a rehearsal exercise prior to conducting sampling for the Kitikmeot Study in QMG. The operations went as planned and the ship was ready to continue its transit straight after lunch, making it possible to sample the first station in QMG during the next night. However, at 17:30 on 19 August the CCGS *Amundsen* was reassigned to Search and Rescue (SAR) operations in the vicinity of Gjoa Haven where two local fishermen were gone missing. The target site was reached in the early morning of 20 August and the ship was released from SAR duties at 14:00 (Local time) the same day. The ship sailed back west and station QMG1 was conducted during the night between 20 and 21 August.

In the morning of 21 August, the decision was made to sail to Cambridge Bay to recuperate the remaining cargo (i.e. food and essential scientific gear) with the hope that the operation could be completed in the same day. Cargo was successfully recovered in the late afternoon of 21 August and scientific operations resumed in the late evening. Shallow stations QMG4 and QMG3 were completed by the early morning of 22 August and operations continued with a mooring recovery (WF1-17) in the morning and another basic station near the mooring site (QMGM) in the afternoon. In parallel, the helicopter was launched to sample Ellice River and Tingmeak River located in the Canadian Wildlife Service Queen Maud Gulf Bird Sanctuary. Sampling was successful in both cases.

Transit towards the oceanographic stations located at the mouth of Lancaster Sound began after completion of QMGM. However, at the entrance of Prince Regent Inlet at 13:00 on 24 August, the CCGS was tasked with a second SAR operation that involved the grounding of the MV *Akademik Ioffe* in the Gulf of Boothia. The ship spent the next two days surveying the grounding site to assess any sign of pollution. The *Amundsen* was released from SAR operations in the afternoon of 26 August and oceanographic station 322 was reached by late evening. Owing to time constraints, only one CTD-rosette cast was conducted at this station. No additional station could be completed in Lancaster Sound.

On Monday 27 August, the ship arrived near coring station 1.1 in eastern Jones Sound. The exact target site identified by the coring team could not be reached owing to heavy ice conditions. An alternate and deeper site was identified where a boxcore and a piston core were conducted. However, the piston core came back on deck almost empty. Concurrently to the coring operations, the helicopter was launched with the glaciology team onboard to conduct a photo survey of the Manson Icefield and recover instruments. It should be also mentioned that the glaciology team had the opportunity to deploy several ice-tracking beacons on drifting icebergs with the helicopter in Northern and Central Baffin Bay during the second half of Leg 3. See their separate cruise report for a summary of operations.

Owing to time constraints during the second half of Leg 3, the historical NOW transect (stations 100 to 116) was severely reduced to only two oceanographic stations. The full station 101 was converted into a basic, where operations involving rosette sampling, nets, trawl and box core deployments were successfully completed. It was also decided to convert the easternmost full station 115 into a basic to be conducted after the transit/sampling to Trinity Glacier. The ship began transiting toward Trinity Glacier after basic station 101 in the late evening of 27 August. Heavy ice conditions in the morning of 28 August prevented the ship to reach the target location. An opportunistic nutrient station was conducted near Trinity Glacier while the helicopter was launched for another photo survey.

Prior to transiting to station 115, an attempt to recover a benthic lander at station 106 was not successful. Communication problems between the deck box and the acoustic release of the lander hindered recovery. On 29 August at midnight, basic station 115 was reached where operations consisted in CTD-Rosette, Tucker net, Monster net, box core and Agassiz trawl deployments. Station 115 was completed before breakfast leaving the morning to successfully recover two moorings in Baffin Bay (BA-05 and BA-06). The next day was spent transiting towards Qikiqtarjuaq. An opportunistic recovery of a Bio-Argo float of the Takuvik program that recently made surface was successfully conducted on the way south.

On Friday 31 August at 6:00 AM, the ship arrived in the vicinity of Qikiqtarjuaq where dignitaries were anticipated for an Arctic Science Workshop aboard the CCGS *Amundsen.* The event was co-hosted by the office of the Governor General of Canada and Amundsen Science. Her Excellency was accompanied by Canada's Chief Science Advisor, the Minister of Science and Sport, the *Amundsen* Project Leader, and representatives from the Canadian Coast Guard, Université Laval, Takuvik and ArcticNet. The delegation joined the vessel's crew to exchange with scientists and community members of Qikiqtarjuaq. In the afternoon of 31 August, the workshop participants could join the deck crew at coring site 1.5 where a piston core was conducted. Operations continued in the early morning of 1 September at basic station 177 where a CTD-rosette, plankton nets and Agassiz trawl were completed. In parallel, helicopter trips to Ice Island PII-A-1-f were organized for the glaciology team. Ice thickness measurements and the demobilization of an autonomous meteorological station on the ice island were accomplished. Workshop participants could join the glaciology team at PII-A-1-f on an opportunity basis. The visitors left the ship in the afternoon of 1 September and the *Amundsen* started sailing south for the return to Quebec City.

On 2 September, a windstorm forced the ship to standby in Sunneshine fjord over night. Once in Sunneshine fjord, an opportunistic CTD-rosette cast was completed along with a dedicated seabed mapping survey. Once the storm waned, the CCGS *Amundsen* started a 6-day transit in direction of Quebec City. The days from 3-9 September were used to clean the laboratories, pack the instruments and samples and prepare for the demobilization. On 9 September at 14:00, the ship docked at the Coast Guard Base of Quebec City.

Part II – Project reports

1 Carbon Exchange Dynamics, Air-Surface Fluxes and Surface Climate – Leg 1 and 2a

Project leader: Tim Papakyriakou[1] (tim.papakyriakou@umanitoba.ca)
Cruise participants – Leg 1: Tim Papakyriakou[1], Dave Capelle[1], Mohamed Ahmed[2], Rachel Mandryk[1] and Yekaterina Yezhova[1]
Cruise participants – Leg 2a: Mohamed Ahmed[2] and Yekaterina Yezhova[1]
[1] *Centre for Earth Observation Science, University of Manitoba, Winnipeg, MB, Canada*
[2] *Geography Department, University of Calgary, Calgary, AB, Canada.*

1.1 Introduction

The biogeochemical cycling of carbon is continually changing within the Arctic Ocean as a consequence of climate change. In particular, Arctic Seas appear to be fresher, and freshwater in the system strongly impacts seawater carbonate chemistry, including air-sea exchange and rates and patterns of acidification. Of all the Arctic Seas, Hudson Bay receives disproportionately large amounts of river input, and many of largest rivers are regulated for hydroelectric production. The impact of river water on the carbon system depends on water properties, which are closely tied to watershed characteristics and season. Our cruise objectives were to measure principal components of the carbon system across Hudson Bay, including those variables deemed most influential at moderating the transformation, transport and distribution of carbon. Central to the cruise objectives were to include in freshwater from the Bay's major rivers. Measurements were made within the water column, at the air-sea (or air-ice) interface, and in the atmosphere.

1.2 Methodology

Multiple observation platforms have been utilized throughout the cruise to collect data pertaining to the atmosphere and the surface ocean, such as a meteorological tower on the ship's foredeck, an underway pCO_2 system in the engine room, an underway FDOM system in the engine room, an underway optode / GTD (PIGI) system in the forward lab, and radiation sensors above the wheelhouse of the ship (Figure 1.1), the ship's rosette, and distributed sampling by helicopter, small boat and on sea ice.

1.2.1 *Automated Systems*

Table 1.1 lists the variables that are monitored, the location where the sensor is installed and height, along with the sampling and averaging frequency (if applicable).

Table 1-1 Summary of variable inventory and instrumentation. Deck height above sea surface was measured on 27-May at 6.4 m.

Variable	Instrumentation	Location	Ht above Main Deck (m)	Ht above sea srfc	Sample/Ave Frequency (s)
Air temperature (Ta)	HMP155A	foredeck tower	8.74	15.14	1 / 60
relative humidity (RH)	HMP155A	foredeck tower	8.74	15.14	1 / 60
wind speed (ws-2D)	RM Young 05106-10	foredeck tower	10.45	16.85	1 / 60
barometric pressure (Patm)	RM Young 61302V	foredeck tower			
incident solar radiation	Eppley Pyranometer (model PSP)	wheel-house platform	On top of wheelhouse		2 / 60
incident long-wave radiation	Eppley Pyrgeometer (model PIR)	wheel-house platform	On top of wheelhouse		2 / 60
photosynthetically active radiation (PAR)	Kipp & Zonen PARLite	wheel-house platform	On top of wheelhouse		2 / 60
$UV_{A\&B}$	Kipp & Zonen UVS-AB-T	wheel-house platform	On top of wheelhouse		2 / 60
wind speed 3D (u, v, w)	CSAT3 Sonic	foredeck tower	9.29	15.69	0.1 (10 Hz)/60
wind speed 3D (u, v, w, Ts)	Gill Wind Master Pro	foredeck tower	7.68	14.08	0.1 (10 Hz)/60
Atm CO_2 and H_2O	LICOR LI7500A	foredeck tower	9.06	15.46	0.1 (10 Hz)/60
Atm CO_2 and H_2O	LICOR LI7200	foredeck tower	9.06	15.46	0.1 (10 Hz)/60
Atm CO_2, CH_4 and H_2O	LGR	foredeck tower	9.06	15.46	0.1 (10 Hz)/60
rotational motion (accx, accy, accz, r x, r_y, r_z)	Systron Donner MotionPak	foredeck tower	9.15	15.55	0.1 (10 Hz)/60
Underway seawater pCO_2, O_2, temperature (Tsw) and salinity	General Oceanics 8050 pCO_2	under-way system, foreward engine room	~-5 m		3 / 60
Weather conditions	Campbell digital camera (CC5MPX)	wheel-house platform	meteorological parameter		2 min

Figure 1-1 The radiation sensors and digital camera located above the wheelhouse of the Amundsen. Shown are the pyrgeometer (right), pyranometer (left) and PAR sensor (centre back) and UV sensor (centre front). The automated digital camera is mounted on the rail below and to the right of the prygeometer.

The micrometeorological tower located on the front deck of the Amundsen provides continuous monitoring of meteorological variables and eddy covariance parameters (Figure 1.2). The tower consists of slow response sensors that record bulk meteorological conditions (air temperature, humidity, wind speed/direction) and fast response sensors that record the eddy covariance parameters (CO_2/H_2O/CH_4 concentration, 3D wind velocity, 3D ship motion, air temperature). All data was logged to Campbell Scientific data loggers; a model CR3000 logger was used for the eddy covariance data, a CR1000 logger for the slow response met data. Eddy covariance data were sampled at 10 Hz while slow response sensors were scanned every 2s and saved as 1-minute averages. All loggers were synchronized to UTC time using the ship's GPS system as a reference. The set-up includes two closed path eddy covariance systems: i) LI-7200 based system (CO_2 and H_2O) and ii) LGR (model) based system (CO_2, H_2O and CH_4). In both systems air was drawn through ½" Synflex® tubing at 10 L/m and ~ 25 L/m, respectively for the LI7200 and LGR systems. Some connections in both systems were ¼". Pressure in the LI7200 was kept within 8%-9% of barometric pressure using a bypass system that allowed higher flow rates upstream of the gas analyzer, thus allowing for turbulent flow. The LI7200 closed-path system was situated at the base of starboard rail inside a weatherproof enclosure, approximately 3 m

from the tower base and approximately 13 m from the intake. Air was partially dried upstream of the gas analyzer using a nafian drier (Perma Pure PD-100T-48SS) and zero gas generator (Aadco model 747-30). Counter flow through the nafian drier was maintained between 13 and 14 lpm. Periodically zero and span gas were introduced to the LI7200.

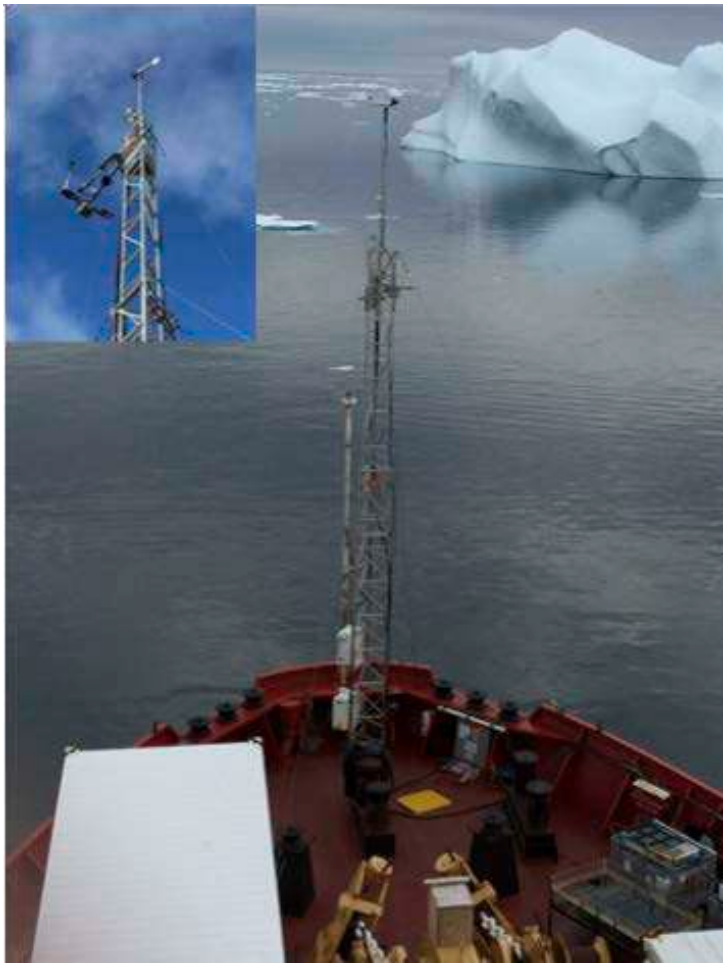

Figure 1-2 The metrological tower located on the foredeck of the Amundsen with EC flux system (inset).

A digital camera (Campbell CC5MPX) was mounted on the forward rail above the bridge and pointed forward to record the ice cover and sea state in front of the ship at 2-minute intervals. The camera has a resolution of 5 megapixels, and is housed in an enclosure to protect it from the elements. An internal heater keeps the temperature of the enclosure above 15°C, which helps prevent ice and moisture buildup on the lens. The camera was connected by a 100' long inverted Ethernet cable to the ship's network via a switch in the Met-Ocean container beside the wheelhouse, allowing pictures to be automatically backed up to a data server in the acquisition room.

A General Oceanics 8050 pCO_2 system has been installed on the ship to measure dissolved CO_2 within the upper 5-7 m of the sea surface in near real time (Figure 1.3). The system is located in

the engine room of the Amundsen, and draws sample water from the ship's clean water intake. The water is passed into a sealed container through a shower head, maintaining a constant headspace. This set up allows the air in the headspace to come into equilibrium with the CO_2 concentration of the seawater, and the air is then cycled from the container into a LI-7000 gas analyzer in a closed loop. The system also passes subsample of the water stream through an Idronaut Ocean Seven CTD, which measured this cruise temperature, conductivity, pressure, and dissolved oxygen. All data was sent directly to a computer using software customized to the instrument. Zero and span were set on the LI-7000 every 8 h using ultra-high purity N_2 as a zero gas, and a gas with known CO_2 concentration as a span gas (474.98 ppm). Additionally, air at two different CO_2 concentrations (315.58 ppm, and 585.20 ppm) were run through the system and are traceable to World Meteorological Organization (WMO) standards.

Figure 1-3 The underway system located in the engine room of the Amundsen.

An underway FDOM sensor has been installed on the ship to measure fluorescence within the upper 7m in response of dissolved organic matter in the water (Figure 1.4). This system located in the engine room on the same intake line that the ship's thermosalinograph system (TSG) system is using for the purpose of data matching later. The FDOM sensor recording the measurements every 30 sec with an FDOM water samples were collecting every 12h for calibrations. The TSG system recording continuous measurements every second for the sea-water temperature, salinity, fluorescence, and sound velocity.

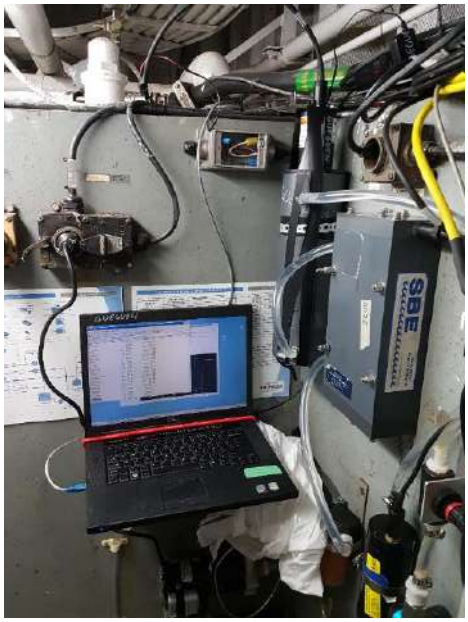

Figure 1-4 The FDOM underway system located in the engine room beside the ship TSG system.

The PIGI (Pressure of In-situ Gases Instrument) has been installed in the forward lab and consist of a 2-stage chamber setup (Figure 1.5). The first chamber (primary camber) consists of debubbler that allows bubbles to exist from the top and bubble-free water to exist via the bottom. The bubble-free water goes to the second chamber, via a downstream pump, that contains two instruments: an Optode and Gas Tension Device (GTD). The optode measures O_2 concentration, and the GTD measures total dissolved gas pressure (which can be used to drive N_2 concentrations.

Figure 1-5 The underway optode / GTD (PIGI) system installed in the forward lab.

1.2.2 *Discrete Water Sampling*

Ship Rosette

Additionally, water samples were collected from the rosette for the analysis of dissolved inorganic carbon (DIC), total alkalinity (TA), stable oxygen and carbon isotopes ($\delta^{18}O$, ^{13}C-DIC; ^{13}C-CH_4), Ba+ and other ions, methane (CH_4), dissolved organic carbon (DOC), total dissolved nitrogen (TDN), and salinity. These measurements will allow us to study the carbon chemistry of various water mixtures across the cruise track. The salinity samples were analyzed on board in the salinometer room by using the AUTOSAL machine to compare it with the salinity log obtained from the CTD rosette and ensure accurate salinity measurements are available for deriving solubility constants for our discrete samples. Other analyses will occur at various labs after the cruise.

Surface Water Sampling (ship bow, zodiac, skippy boat)

Water samples for DIC/TA, $\delta^{18}O$, CH_4, and salinity were collected from the ship foredeck, zodiac or skippy boat at 3 different depths (surface, 1m and 7m) using a horizontal Niskin bottle to estimate any errors introduced in air-sea flux by using the data from the underway system sampling at 7m depth.

Table 1-2 List of stations sampled during Leg 1

Station	Station type	Water sampling location
44	Nutrient	Foredeck
43	Nutrient	Foredeck
41	Nutrient	Foredeck
40	Basic	Skippy / on ice
39	Nutrient	Foredeck
38	Basic	Skippy / on ice
37	Nutrient	Foredeck
36	Basic	On ice
35	Nutrient	Foredeck
34B	Full	Zodiac
34A	Full	Zodiac
32	ice	on Ice
31	Full	Foredeck
28	Nutrient	Foredeck
27	Nutrient	Intercalibration (O18)
25	Full	Intercalibration (DIC/TA)
24	Basic	On ice
22	Full	Zodiac
21	Full	Zodiac
19	Basic	Zodiac
18	Full	Skippy
17	Basic	Zodiac
16	Basic	Skippy
15	Mooring Station	Foredeck
11	Nutrient	Foredeck
10	Nutrient	Foredeck
9	Basic	Foredeck
7	Nutrient	Foredeck
5	Nutrient	Foredeck

4	Nutrient	Foredeck
3	Nutrient	Foredeck
1	Nutrient	Foredeck

Helicopter Sampling

The helicopter was used to sample from ice floes, rivers, and land fast ice. At each site, ice-water interface water samples were collected, and occasionally a second, deeper sample (7 m), using a submersible pump (Waterra Cyclone pump) powered by a 12V battery. Water was pumped through 3/8" ID vinyl tubing into 250 mL BOD glass bottles with sintered glass stoppers, and 4 L glass jars with narrow mouth plastic screw caps. Samples were stored in the dark and processed/preserved upon return to the ship within 4 hours of sampling, for DIC, TA, ^{18}O, Ba, CH_4, ^{13}C-DIC, ^{13}C-CH_4, salinity, DOC, TDN. Subsampling from the 4L glass bottle was done using a 50 mL glass syringe with a 15 cm long 1/8" ID vinyl tube attached to the end. The syringe was rinsed 3X with sample water and filled without bubbles before rinsing and filling sample bottles, also without bubbles.

CTDs were always performed when water samples were collected by helicopter, up to 50 m depth using an Idronaut.

Ice and under-ice water

Ice cores were collected at select ice stations accessed either by the ship's cage or helicopter. Up to 5 x 10cm sections were vacuum sealed from each core and melted at room temperature before subsampling for ^{18}O, Ba, Salinity, DIC, and TA. In many cases only the upper 1m of ice was sampled due to the very thick ice cover and time constraints. Where possible, under ice water was collected by submersible pump and subsampled in the same bottle as under-ice water collected by helicopter (see above).

1.3 Preliminary Results

The data at this time are very preliminary and require additional processing before making reliable inferences, but it appears that the bay is overall under-saturated in pCO_2, suggesting the bay is net autotrophic and a net sink for atmospheric CO_2 during the spring. Unfortunately, no preliminary results from discrete water samples are available at this time.

1.4 Comments and Recommendations

At this time, we have no recommendations that would improve sampling rate or efficiency. However, we will plan to install a flow sensor next year on our intake line in the engine room to make sure the pump is not running when the intake line is clogged with ice (or flow rate less than 1 L/min) and connect the underway data with our network connection in the acquisition room. A

kind reminder that when we are at station that the ship be pointed into the wind (when possible) so that the ship's smoke is not blown towards the met tower.

2 Climate and Marine System - Sea Ice – Leg 1

Project leaders: David Barber[1] (david.barber@umanitoba.ca) and Jens Ehn[1]
Cruise participants – Leg 1: David Barber[1], Greg McCullough[1], David Babb[1], Maddison Harasyn[1] and Laura Dalman[1]
[1] *Centre for Earth Observation Science, University of Manitoba, Winnipeg, MB, Canada*

2.1 Introduction

The BaySys 2018 cruise provided a unique opportunity to sample the seasonal ice cover in Hudson Bay during the melt season. Previously during February and March 2017, as part of the BaySys program, mobile sea ice was sampled near Churchill via helicopter, and landfast ice near the Nelson estuary via snowmobile. Combined, these three programs provided the opportunity to sample landfast and mobile sea ice during both the winter and summer months, and gain a more complete understanding of the seasonal and spatial variability in the sea ice cover of Hudson Bay.

While many other teams onboard the Amundsen were interested in collecting ice samples for carbon, mercury, contaminants, nutrients, and biology/optics our team was interested in characterising the physical properties of the ice cover. This data will go towards our own research, but also provide context on the ice conditions for the other BaySys teams. In order to describe the physical properties of an ice cover we were interested in describing the temperature and salinity profiles within the ice, measuring its thickness, assessing its roughness, quantifying its aerial concentration and the floe size distribution, monitoring its radiometric signatures to compare to satellite observations, and tracking its drift. To do this, we used a variety of field techniques from direct in situ physical measurements, to remote sensing and autonomous platforms that remained on the ice cover. Below is a brief description of our methods and examples of the preliminary results that we have collected.

2.2 Methodology

2.2.1 *Ice Sampling*

Ice samples were collected using a 9 cm Mark II Kovacs core barrel. Full or partial ice cores were taken to measure the temperature and salinity throughout the sea ice. Holes were drilled to the center of the core at 10 cm intervals beginning 5 cm from the ice-air interface. A Traceable Digital Thermometer was then inserted into the drilled hole and temperature was recorded. Salinity ice cores were cut with a saw into 10 cm sections, put into buckets, melted overnight, and salinity measurements were taken with a Thermo Scientific Orion 3-star salinometer from pure melt the following day. These profiles provide information on the state of the sea ice to assess whether the ice is growing or melting. An ice core for temperature and salinity was taken at every ice station for a total of 15 stations throughout Hudson Bay. Partial ice cores were taken only in southern Hudson Bay where the ice was much thicker with ice floes >3m thick.

Figure 2-1 Laura Dalman measuring the ice temperature profile of an ice core

Manual measurements of ice thickness were collected at each site with a 2" kovacs ice auger and a Kovacs ice thickness tape. Both the manual auger head and a Stihl gas-powered auger were used to drill holes at specific sites or along transects. Additional ice thickness measurements were to be collected with a towed Electromagnetic Induction System, however both systems were malfunctioning and were therefore not used.

2.2.2 *Remote Sensing*

During the 2018 BaySys Leg 1 field season, passive microwave radiometric scans of ice floes were completed at 14 stations located in the north/northwest and southwest sectors of Hudson Bay. Scans were completed while situated beside the ice floe which would later be sampled for physical properties, at incidence angles ranging from 25 – 80o in both horizontal and vertical polarizations at 19, 37 and 89 GHz. Physical sampling was then completed after scanning on the ice, measuring snow presence/depth, wetness, and salinity within the footprint of the radiometer. Drone surveys were also completed for 11 of the 14 full stations to capture an aerial survey of the sampled floe and surrounding area. Drone surveys were completed using a DJI Phantom 4 and DraganFly Commander, which capture RGB and multispectral imagery respectively. Aerial imagery was used to classify sea ice surface features, such as melt pond size or sediment presence. As well, digital elevation models were generated using photogrammetric techniques, providing a 3D model of the surface roughness of sea ice within the survey area. Physical and drone sampling was combined to classify the physical properties of the scanned floe, to be compared to the measured brightness temperatures from the passive microwave radiometer.

Sampled ice at each of the stations varied in melt progression, ice composition and surface characteristics. Ice sampled during early June in the north sector of the bay showed no melt features, with all ice floes being very large with a more uniform surface elevation. Floes were

covered with a layer of dry fresh snow (~10 cm) covering a deeper layer of saturated, highly saline snow (~5 cm). The radiometric signature of these floes shows uniform brightness temperatures across the range of incidence angles, with brightness temperatures residing between 170 and 270 K for each frequency/polarization.

Ice in the southwestern sector of the bay had different physical and surface properties compared to the northern ice. This ice was sampled during late June, meaning that melt features were more prominent. Ice in this area contained sediment in the surface layer, had larger ridge features, and was thicker than the northern ice. Snow on the ice was thinner (~3 cm) and was fresh. Melt ponds were often covered by a layer of ice (~1 cm thick). The radiometric signature of this ice was slightly different, showing diverging brightness temperatures at higher incidence angles. As well, brightness temperatures for the horizontal polarization varied greater than the vertical polarization over the range of incidence angles.

2.2.3 *Autonomous Instruments*

Ice Beacons

To measure sea ice drift 10 ice beacons were deployed on large ice floes in central and southern Hudson Bay. Ice Beacons are contained within sealed PVC tubes (13 cm diameter x 50 cm length) that house a small processor, GPS and Iridium antennae, and a battery pack. Once the units are activated they transmit their GPS location at user-defined intervals (typically 1 hour) to an online web portal. The ice beacons transmit their location until the ice floe breaks up and they sink.

Beacon #	IMEI	Deployment Date	Coordinates
17	607220	18-06-2018	58.61729 -89.57683
19	206980	19-06-2018	57.72522 -88.05737
23	503520	19-06-2018	57.12653 -88.35158
13	504190	20-06-2018	56.60985 -87.08107
21	300430	21-06-2018	54.40994 -85.89129
26	908870	21-06-2018	56.10707 -84.56303
25	907730	22-06-2018	57.87995 -84.22141
18	201080	22-06-2018	58.29801 -87.60599
20	300000	23-06-2018	59.26393 -87.99193
22	300440	23-06-2018	58.79762 -84.22619

Table 2-1 Ice drift Beacon deployment details

Below is a map of the 10 beacon locations and near-real time sea ice concentration (0 - 100%) from June 24th. The 10 beacons provide good spatial coverage of the ice cover and will hopefully last well into July as the ice cover melts out and breaks up. Note that the near-real time sea ice concentration is provided by NSIDC and is based on space borne passive microwave sensors

that have known limitations during the melt season due to liquid water at the ice surface. Ice charts from the Canadian Ice Service provided higher resolution data that is more reliable, but for this exercise the near-real time data is suitable.

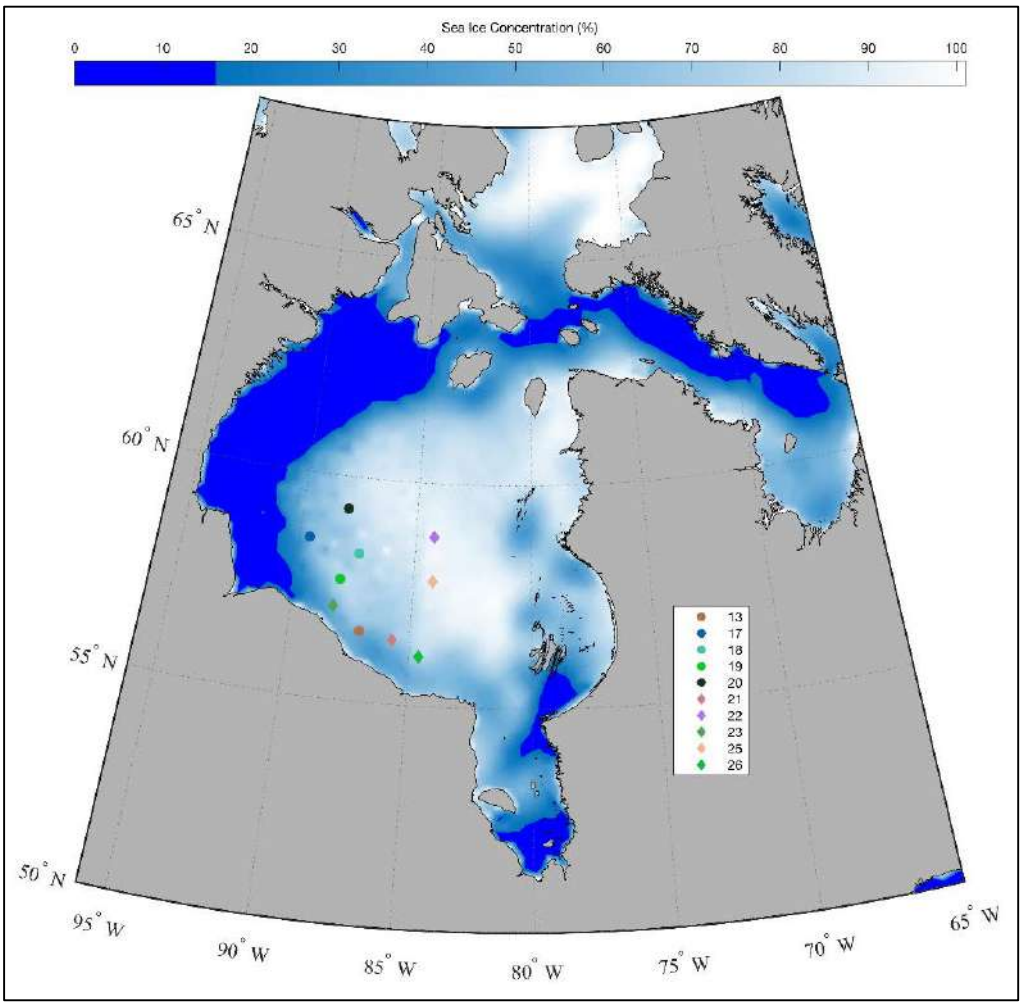

Figure 2-2 Ice beacon positions and sea ice concentration on June 24th, 2018

Short Deployment of on-ice Weather Station and CT Lines

Taking advantage of our multiple trips across the marginal ice zone in northwestern Hudson Bay we deployed a suite of autonomous instruments for a 6-day period to capture a high-resolution dataset on atmosphere-ice-ocean interactions. Two ice tethered moorings and a meteorological station were deployed on large pans of sea ice. The mooring lines contained CT sensors and an upward looking ADCP, while the meteorological station contained an Air temperature sensor (Campbell Scientific 107 Temperature Probe), a barometer (Campbell Scientific 61302V), turbine anemometer (RM Young 05106-10 Wind Monitor, Marine) and an under-ice acoustic sounder (Teledyne Benthos 9602) to monitor sea ice melt. To correct the wind direction for floe rotation an electronic compass (R.M. Young 32500) was calibrated and setup on the tower, while an additional ice beacon was deployed ~50m from the co-located ice tethered mooring to provide two GPS positions to verify the compass measurement of floe rotation. The station was operated

by a CR-1000 and powered by a Lithium Ion Battery, both of which were located in the white weatherproof enclosure visible in Figure 2.3. The systems were deployed on June 6th and recovered on June 12th, both via helicopter. A complimentary ice core was collected during deployment, however no core was collected during recovery because the floe had broken up considerably and the mooring and met station was recovered while the helicopter hovered.

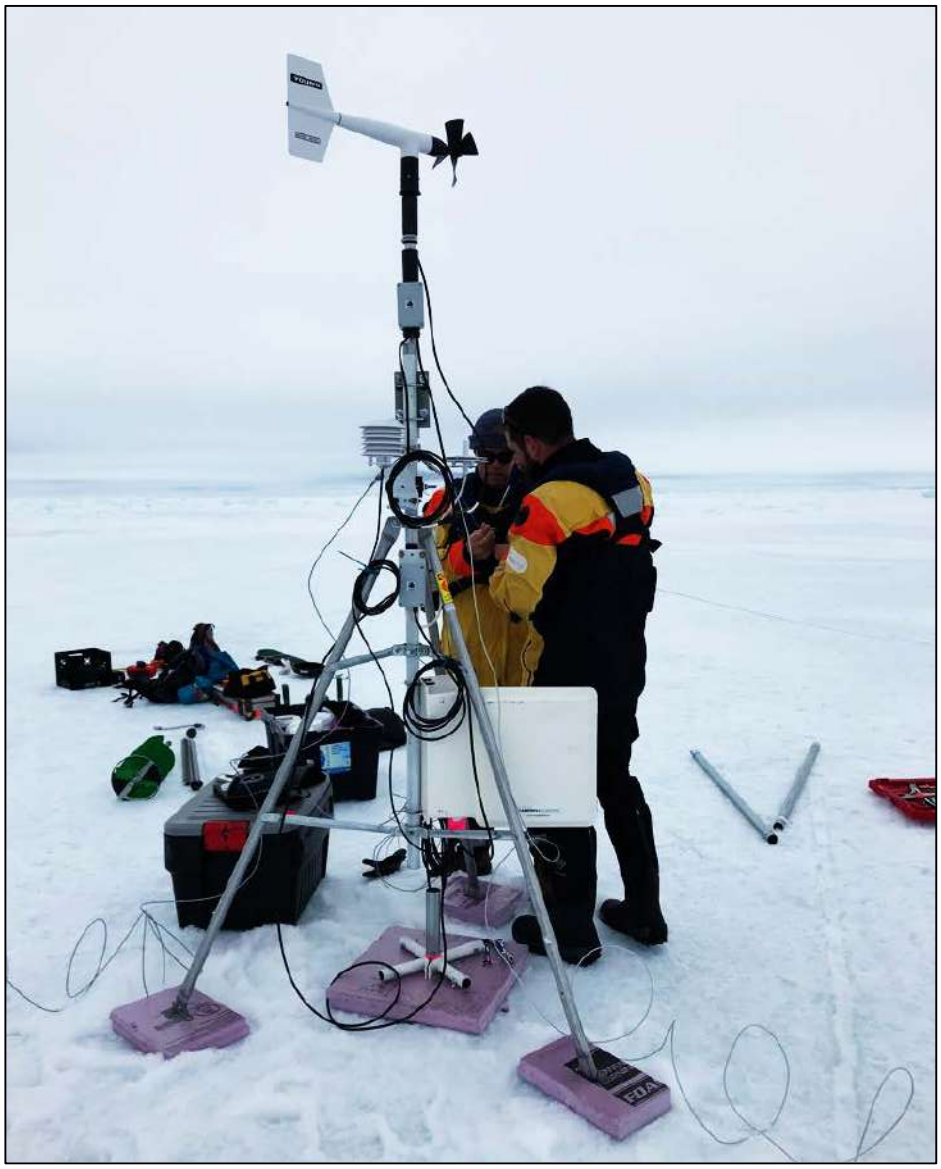

Figure 2-3 Photograph of the on-ice meteorological station setup

Figure 2-4 The surface portion of the ice-tethered mooring. There is a GPS tracker within the surface unit that allowed us to recover the unit after 6 days

2.3 Preliminary Results

2.3.1 *Physical Samples*

Two samples profiles of the Temperature and Salinity are provided below. Overall the sea ice was relatively warm and near isothermal at every site. The salinity varied from values typical of first year sea ice (5 – 7) to values indicative of freshwater ice (0 – 1).

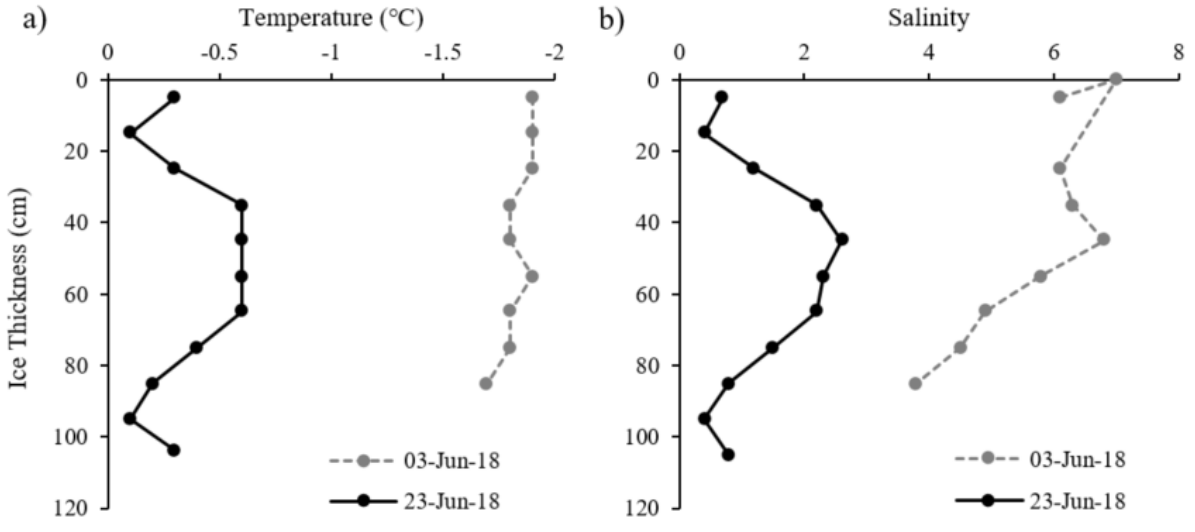

Figure 2-5 Temperature (a) and salinity (b) profiles for ice floes sampled in northern Hudson Bay (03-Jun-18) and southern Hudson Bay (23-Jun-18)

2.3.2 *Autonomous Instruments*

Ice Beacons

Below are two examples of the ice beacon data from beacons 21 and 26. A map with the points coloured by ice drift speed (km/d) and the time series of ice drift speeds are provided for each beacon. The ice clearly quite mobile and in near constant motion, with frequent reversals and loops along its trajectory. The periodic loops are to the left of the trajectory and are therefore not inertial, but instead likely tidally driven. This will be explored further following the loss of all ice beacons in late-July or early-August. Note that there is a 5 day gap in the data during early July, the Iridium servers at Solara Communications were down during that time and they are in the process of retrieving this data from the Iridium servers.

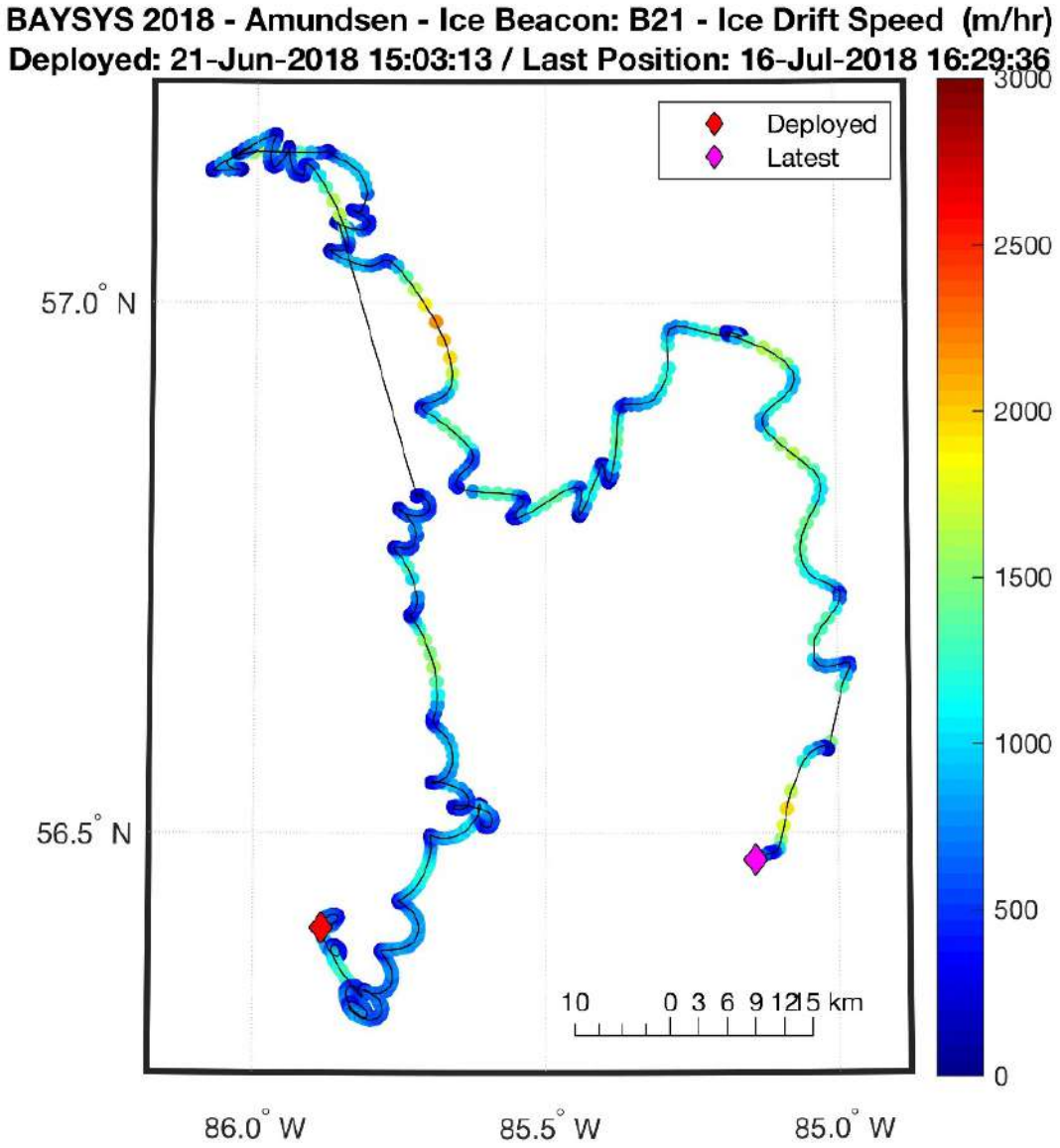

Figure 2-6 Ice beacon 21 position and drift speed

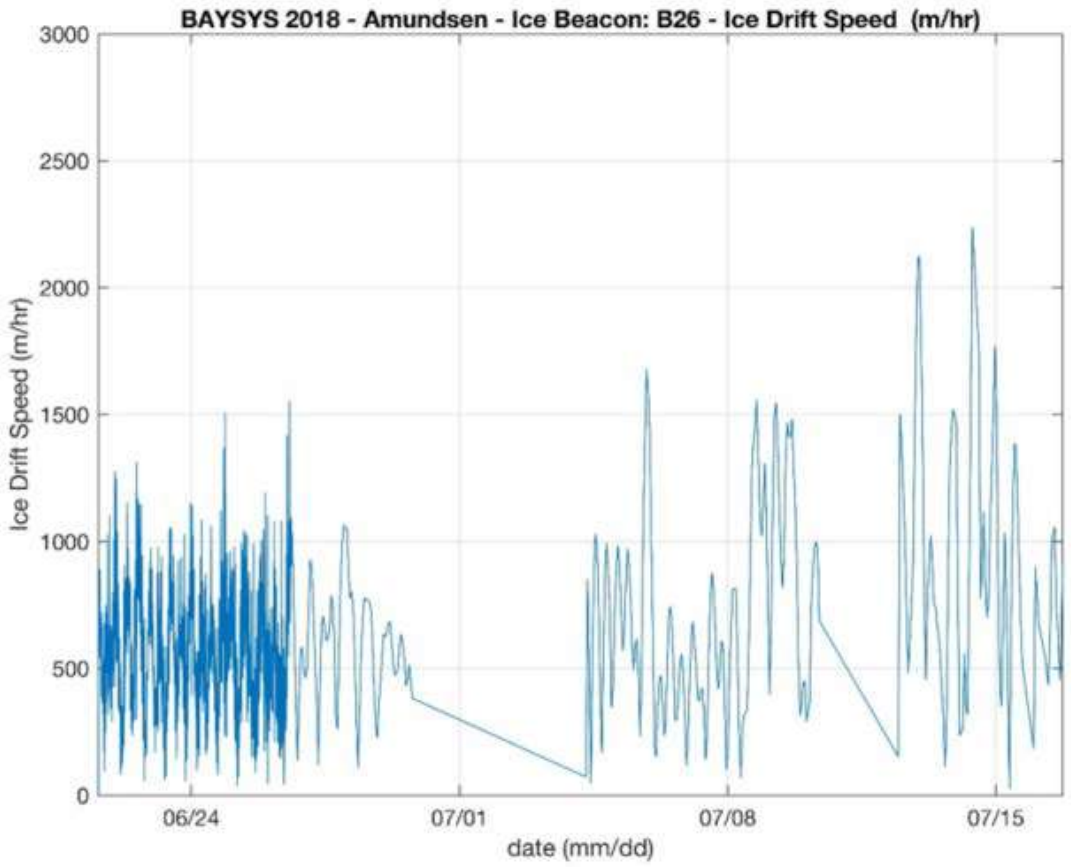

Figure 2-7 Ice beacon 26 drift speed

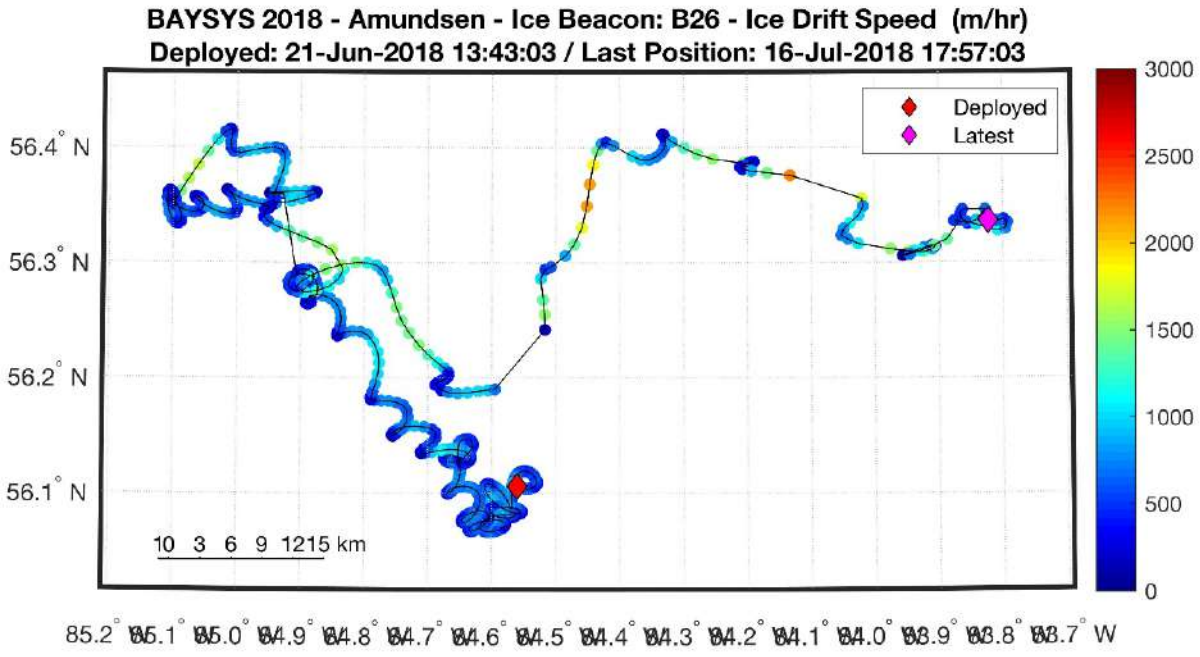

Figure 2-8 Ice beacon 26 position and drift speed

2.4 Comments and Recommendations

Overall the safety on the ship is very good, specifically with the new regulations about survival suits and ditching training for those working in the helicopter. However, I (Dave Babb) still have concerns related to tying off the harnesses within the ice cage. I know the harnesses are not tied off to the cage, and are instead connected to the crane, but if the cage did ever give out it seems like there would be a tangle of wires as the cage fell and that those harnessed into the cage would be entangled within the wires. I completely understand being harnessed in while sampling thin ice from the cage with the gate open, however during the transfer of people from the ship to the ice I worry about having my harness being entangled within the ice cage frame/wires. Perhaps it's worth discussing how other groups access sea ice off the side of an icebreaker.

3 Glaciers, Icebergs and Photogrammetry – Leg 3

Project leaders: Luke Copland[1] (luke.copland@uottawa.ca), Andrew Hamilton[1] and Alison Cook[2]
Cruise participants – Leg 3: Abigail Dalton[1], Claire Bernard-Grand'Maison[1], Adam Garbo[3] and Jesse Smith[3]
[1] Laboratory for Cryospheric Research, University of Ottawa, Ottawa, ON, Canada
[2] Geography Department, Durham University, Durham, United-Kingdom
[3] Carleton University, Ottawa, ON, Canada

3.1 Introduction

Tidewater glaciers drain glaciers, ice caps and ice sheets and terminate into the ocean where they discharge through the calving of icebergs and ice islands (large tabular icebergs). The Canadian Ice Service (CIS) produces charts to identify the presence of icebergs but has little knowledge about the sources and sinks of icebergs in Canadian waters. It is important to understand where these icebergs and ice islands originate, where they drift, how they deteriorate and the time scale of these processes. Trinity and Wykeham Glaciers on SE Ellesmere Island have increased iceberg production from 22% of total discharge from the CAA (Canadian Arctic Archipelago) in 2000 to 66% in 2018. They are the only two glaciers in the Queen Elizabeth Islands (QEI) to have shown consistent acceleration between 1999 and 2015 making it an area of significance for the study of ice discharge into Canadian Waters (Van Wychen et al., 2016). Operations during this leg will address the following gaps in knowledge surrounding the production and movement of icebergs and ice islands in Canadian waters:

- Which tidewater glaciers are the sources of icebergs and ice islands in Canadian waters and where do they drift?
- Are there changes in the size, shape or timing of iceberg production in the recent past and is this linked to glacier dynamics?
- Do sea ice conditions impact the production of icebergs at the termini of tidewater glaciers?
- How is the velocity of Trinity Glacier changing over time?
- What is the volume change of CAA glaciers over the past few decades?
- Is there a pathway for Atlantic Water to access the terminus of Trinity Glacier
- How do ocean properties and circulation in the inlet vary spatially and temporally?
- Was the ocean able to drive enhanced submarine melting and trigger the retreat?

3.2 Methodology

3.2.1 *Iceberg Beacon Deployment*

Between August 27, 2018, and September 3, 2018, a total of nine tracking beacons were deployed by helicopter on icebergs and ice islands in Talbot Inlet (SE Ellesmere Island) and Baffin Bay (Table 3.1). The targets were chosen based on size, location and whether they were likely to drift. All nine beacons have since successfully transmitted data remotely. Five of the iceberg tracking beacons contain Yellowbrick Rockstar iridium GPS receivers, batteries and solar panels.

The remaining six iceberg tracking beacons contain Solara Iridium GPS receivers and batteries (Figure 3.1).

One tracking beacon was deployed onto an iceberg in Talbot Inlet to track movement of icebergs produced by Trinity Glacier within and out of the inlet. In total, eight beacons have been deployed onto icebergs in Talbot Inlet between 2016 and 2018. Three beacon deployments were planned for Talbot Inlet. However, these were not possible due to poor weather conditions.

A tracking beacon was also deployed onto an ice island fragment near Talbot Inlet on August 28, 2018. This ice island broke off of the Petermann Glacier (northwest Greenland) in 2017 (Figure 3.2). Initial results show that this ice island has drifted ~60 km between August 28 and September 4, 2018, and is moving in the southwest direction in small loops (Figure 3.3). Positions of all nine beacons will be tracked hourly to monitor movement and identify drift patterns of icebergs around Baffin Bay. Transmission frequency can be reduced remotely in the winter months when drift is reduced due to sea ice and the beacons are GPS transmitters are unable to report their position through snow.

Table 3-1 Iceberg beacons deployment summary.

Serial Number	Deployment Date	Deployment Time (local)	Start Position (Latitude, Longitude)	Deployment Location	Notes
545280	August 27, 2018	09:36	75° 46.27 N 078° 30.98 W	E of Coburg Island	170-200ft freeboard, blocky
3541	August 28, 2018	08:15	77° 58.220 N 078° 29.266 W	Talbot Inlet	Near Trinity Terminus
4600	August 28, 2018	08:28	77° 35.80 N 077° 02.79 W	E of Ellesmere	Petermann Ice Island Fragment
3525	August 29, 2018	13:00	75° 09.57 N 070° 09.00 W	Baffin Bay	Deployed with rope, 150-200ft freeboard, wedge shape
549280	September 1, 2018	16:27	67° 29.468 N 063° 18.831 W	Qikiqtarjuaq	Suspected PII_2012_A_1-F fragment
549270	September 1, 2018	16:32	67° 32.311 N 063° 21.855 W	Qikiqtarjuaq	Suspected PII_2012_A_1-f fragment
441790	September 1, 2018	16:42	67° 39.594 N 063° 07.868 W	Qikiqtarjuaq	Suspected PII_2012_A_1-F fragment, ~75ft freeboard
443790	September 3, 2018	10:57	66° 28.17 N 061° 31.65 W	Cape Dyer	
3386					
3273					

Figure 3-1 Iceberg tracking beacons: (a) Rockstar Iridium and (b) Solara Iridium Photos: Abigail Dalton.

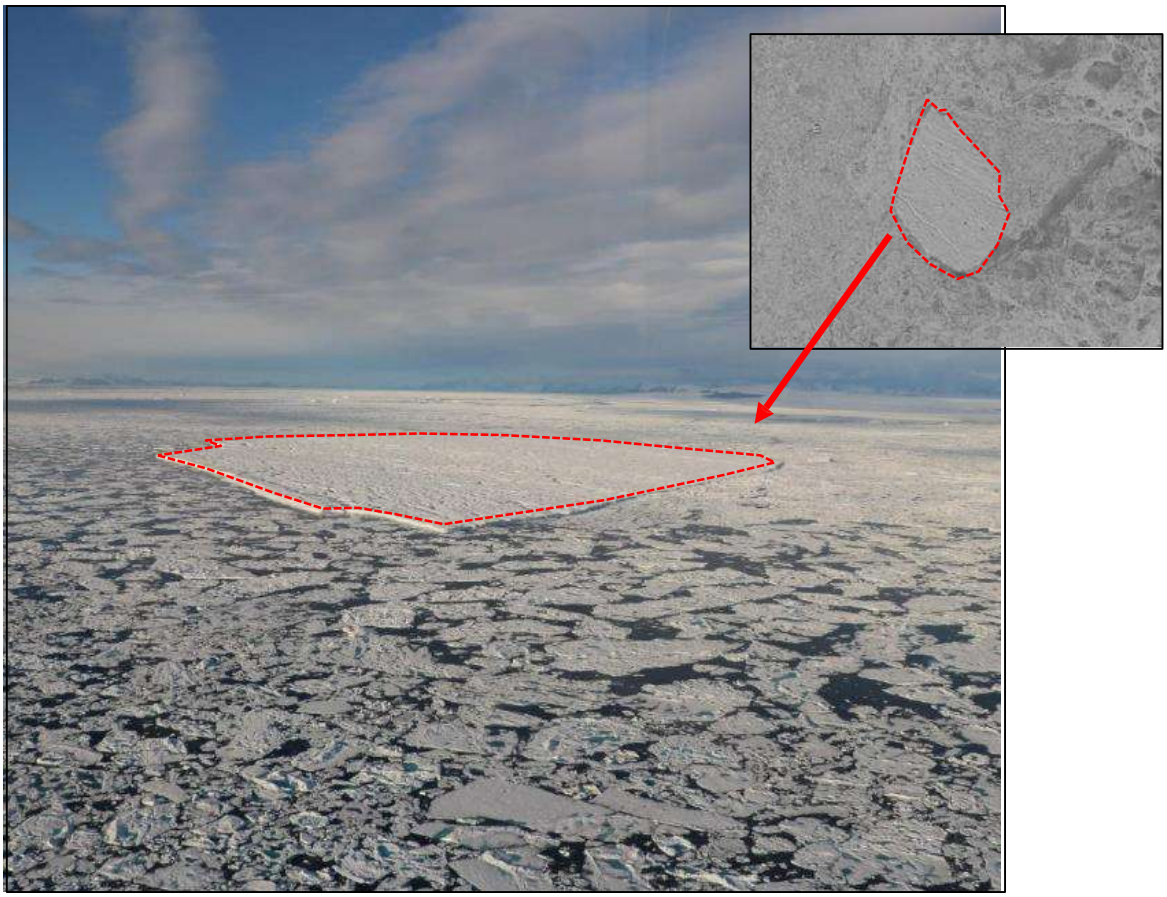
Figure 3-2 Photograph and Landsat-8 image (August 8, 2018) of Petermann Ice Island fragment near Eastern Ellesmere island where a tracking beacon (Rockstar #4600) was deployed on August 28, 2018. Photo: Abigail Dalton.

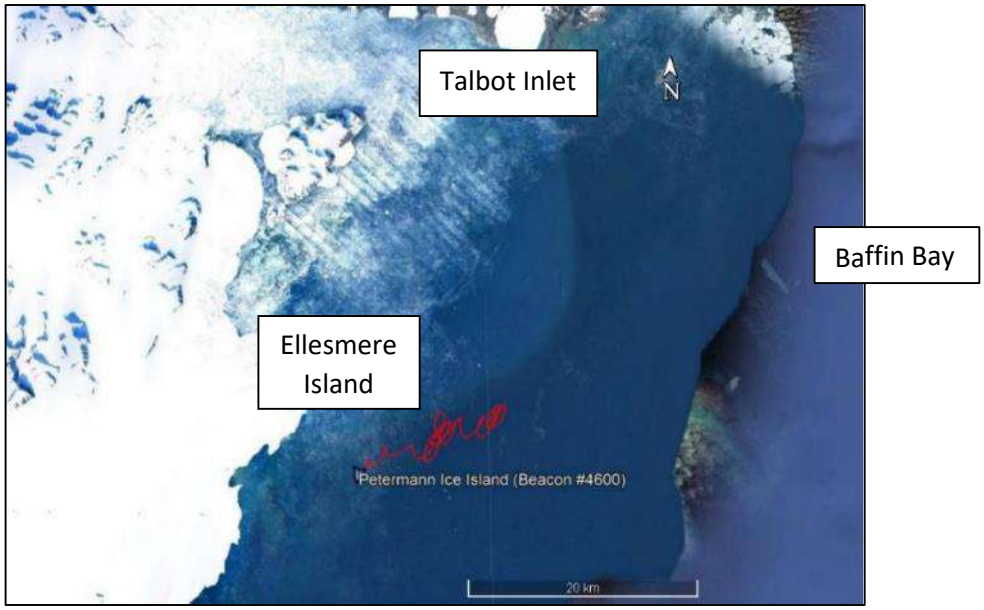

Figure 3-3 Drift pattern of Petermann Ice Island fragment shown in Figure 2 between August 28, 2018 and September 4, 2018.

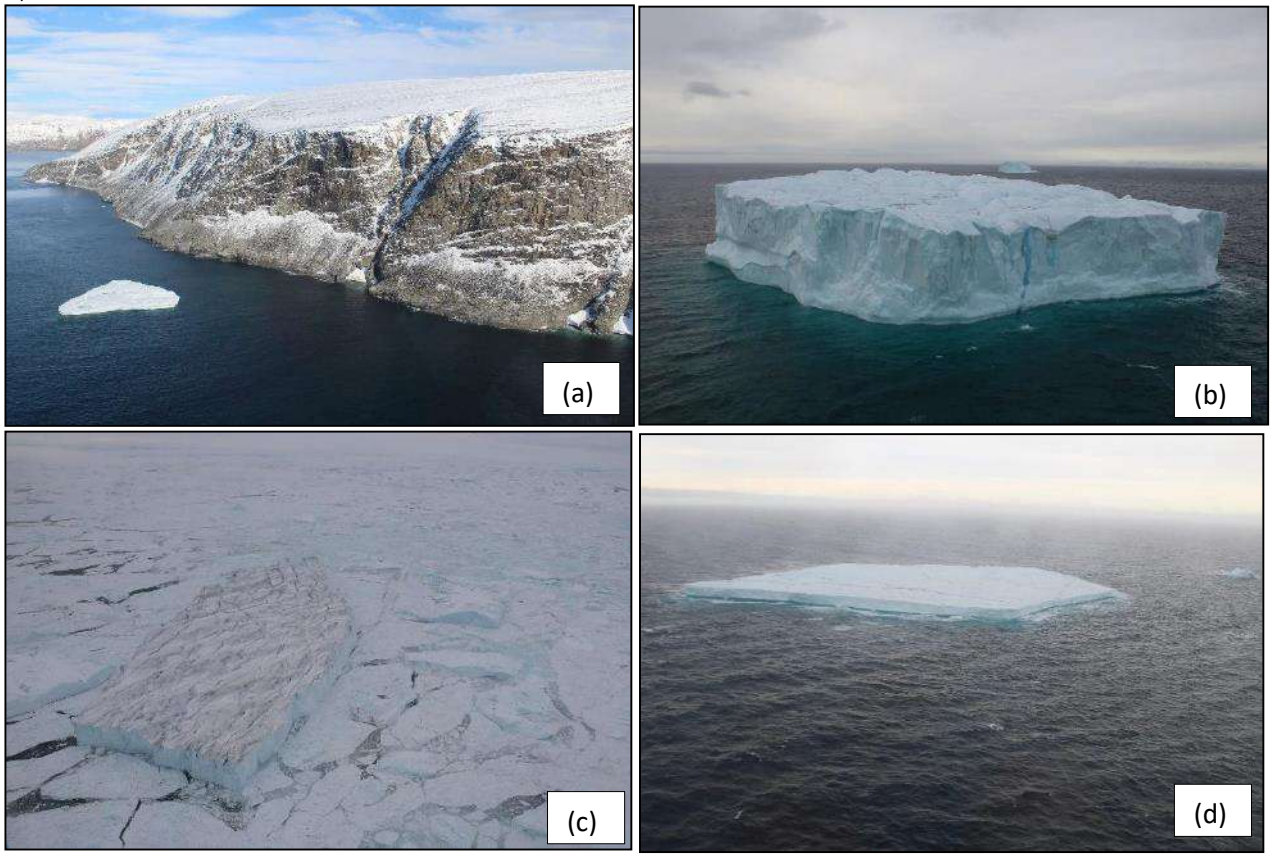

Figure 3-4 Examples of additional iceberg tracking beacon targets between August 27, 2018 and September 3, 2018. (a) Sunshine Fiord, Baffin Island, September 3, 2018, (b) East of Coburg Island, August 27, 2018, (c) Talbot Inlet, August 28, 2018, (d) East of Qikiqtarjuaq, September 1, 2018. Photos: Abigail Dalton.

3.2.2 *Ice Islands Measurements*

An ice depth measurement was taken on the 2017 Petermann Ice Island Fragment during our visit there on August 28, 2018. A tracking beacon was deployed to monitor its movement and a 10 MHz GPR (ground-penetrating radar) was used to measure the thickness. The ice island was found to be ~40 m thick. Plans were made to take ice depth measurements on icebergs when beacons were deployed. However, all other beacons were deployed using a hover exit due to the rough surface and potential instability of the icebergs.

3.2.3 *Talbot Inlet Equipment Maintenance*

Work in Talbot Inlet was not completed this year due to poor weather conditions (Figure 2.5). The goal of this work was to recover data from previously installed stations at 3 points on/around the glacier.

Figure 3-5 Weather conditions in Talbot Inlet on August 28, 2018 that prevented us from completing our work. Photo: Adam Garbo.

Differential GPS Stations

Two differential GPS systems (dGPS) were installed on Trinity Glacier on August 10, 2016, to monitor changes in glacier velocity. The first station was originally located down-glacier (78º01' 54.94''N, 78º50'56.40''W) and contains a battery and solar powered dGPS system (Trimble NetR9 & XI-100). In 2017, this station was found to be perched on the side of a crevasse. Instruments were recovered from the station and it was removed from the glacier in 2017. The second station was installed up-glacier (78º01'51.75''N, 79º12'14.62''W) and has since moved to 78º2.12'N, 079º10.88'W as of July 30, 2018, and contains a battery and solar-powered dGPS (Trimble R7). Both stations transmit data remotely through Iridium connection and include south-looking solar-powered time-lapse cameras (SpyPoint) facing ablation stakes marked with 5 cm

increments to monitor surface melt rates. Time-lapse cameras are programmed to take photos hourly. This station was spotted from the air and photos were taken of its location (Figure 6). It was partially snow covered and low contrast/fog meant we were unable to land for data recovery. When we are able to access the site, data will be downloaded and the station will be dismantled and removed from the glacier.

Figure 3-6 Aerial photo of upper dGPS station of Trinity Glacier, August 28, 2018. Photo: Adam Garbo.

DSLR Timelapse Camera System

A DSLR camera (Canon EOS Rebel T6i with EF-S 24mm f/2.8 STM lens) was installed on a nunatak between Trinity and Wykeham Glaciers (77°55'50.64 N 78°37'27.31 W) on August 10, 2016. The camera is housed within a Harbortronics unit mounted on a tripod. The camera is connected to a battery for power through the winter with a solar panel mounted on the tripod for power during the summer months. The camera faces the terminus of Trinity Glacier and is set to take photos every hour to monitor iceberg production. This site was visited on July 28, 2017 to download imagery. A visit was scheduled to this site on August 28, 2018 however it was inaccessible due to fog. Aerial photographs were taken of the site (Figure 3.7). Planned work at this site included downloading photos from the camera and reprogramming the intervalometer.

Two additional SpyPoint cameras (adjacent to the DSLR camera location) were installed between Trinity and Wykeham Glaciers, one facing the terminus of Wykeham Glacier and one facing outward towards the mouth of the fiord. Photos were intended to be downloaded from these cameras. All three cameras at this site should continue to take hourly photos of Talbot Inlet over the next year.

Figure 3-7 Aerial photo of DSLR camera site on Nunatak between Trinity and Wykeham Glaciers, August 28, 2018. Photo: Adam Garbo.

Talbot Inlet Mooring Deployment and Recovery

The propagation of a warm subsurface Atlantic Water anomaly around the coast of Greenland has been linked to the widespread acceleration and retreat of tidewater glaciers in Greenland. A similar pattern of acceleration and retreat has been observed for Trinity and Wykeham glaciers, which terminate in Talbot Inlet, SE Ellesmere Island. Together, these two glaciers account for >60% of all icebergs produced in Canada. The aim of this project is to understand the role of the ocean in triggering these changes. Specifically, we want to understand: Is there a pathway for Atlantic Water to access the glacier termini? How do ocean properties and circulation in the inlet vary spatially and temporally? Was the ocean able to drive enhanced submarine melting and trigger the retreat? The observations collected during this cruise would have been used to investigate these questions, and to conduct high-resolution numerical ocean circulation modelling of the region to understand the past and future potential for the ocean-forcing of tidewater glaciers in the Canadian Arctic.

Planned operations in Talbot Inlet and coastal Ellesmere Island included:

- Multibeam sonar bathymetric mapping
- Oceanographic (CTD/ADCP) surveys
- Deployment of a subsurface mooring
- Recovery of a drifter mooring

3.2.4 *Operations during Leg 3*

Unfortunately, due to the large presence of sea ice within Talbot Inlet and the surrounding area, the Amundsen was unable to gain access to the target mooring deployment and drifter mooring recovery sites. In addition, icebreaking operations were required during the transit to and from Talbot Inlet, which prevented the acquisition of any useable multibeam sonar bathymetric mapping data. However, while the ship awaited the return of the helicopter with the team deployed to conduct fieldwork on Trinity Glacier, a cast of the CTD Rosette was performed to a

depth of 600 m. This cast was located approximately 50 km from the entrance to Talbot Inlet (77° 27.7218'N, 75° 54.3168'W), which may help to provide a better understanding of the spatial variability of water properties in the region.

Glacier Photo Surveys of the Queen Elizabeth Islands

This work is a continuation of photo surveys undertaken on Leg 2b in 2017 by Alison Cook. Due to poor weather conditions and time constraints, only one survey on 10 potential surveys were conducted in 2017. We were given the information and planned flight lines for the remaining nine potential survey locations (North of Devon Island Ice Cap and Eastern Ellesmere Island) and we expected to complete at least two surveys on this leg.

The aim of the photo surveys is to produce high resolution digital elevation models (DEMs) of the ice surface for specific glaciers that will be compared to similar models created from aerial photographs from 1959. Combined with knowledge of the advance or retreat in terminus positions of the specific glaciers, this comparison will enable the calculation of volume change of these glaciers over the past ~ 50 years and the estimation of their input of fresh water in the ocean. The technique used to produce the DEMs is called "Structure from Motion", whereby overlapping photographs taken from an aircraft can be mosaicked in a specific software to reconstruct a 3D surface using photogrammetry principles. This method requires ground control points and/or precise position of the camera when the photos are taken to properly georeference the imagery and to increase the accuracy of the elevation models.

On August 27, 2018, we were able to conduct three photo surveys (Table 3.2): one in the morning on Devon Ice Cap (Figure 3.8) during transit of the ship and two in the afternoon on Manson Icefield (Figure 3.9) during the piston core at Site 1.1. When departing for Devon Island, the clouds were low and covering the top of the ice cap. With low contrast the helicopter pilot accepted to do our shortest planned survey that was located the closest to shore and in the direction of the ship. In the afternoon, the weather was perfect with sunny and blue sky for the Manson Icefield surveys.

Table 3-2 Information on the three photo surveys conducted on August 27th, 2018

Survey Name	Location	Start point (Latitude, Longitude)	Number of completed flight lines	Number of photos taken
Devon 2	NE of Devon Island Ice Cap	75°34.63' N 80°23.73' W	3	436
Manson 1	SE of Manson Icefield on Ellesmere Island	76°38.60' N 79°06.33' W	5	971
Manson 2		76°32.93' N 78°41.29' W	4	409

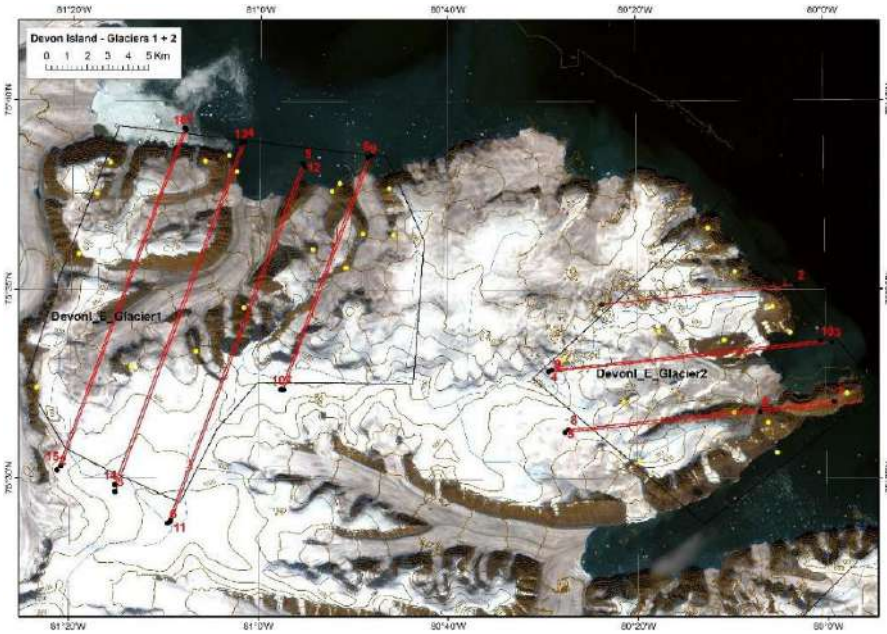

Figure 3-8 Map of the planned photo surveys flight lines on Devon Ice Cap, only the Devon 2 survey (left) was conducted. Credit: Alison Cook.

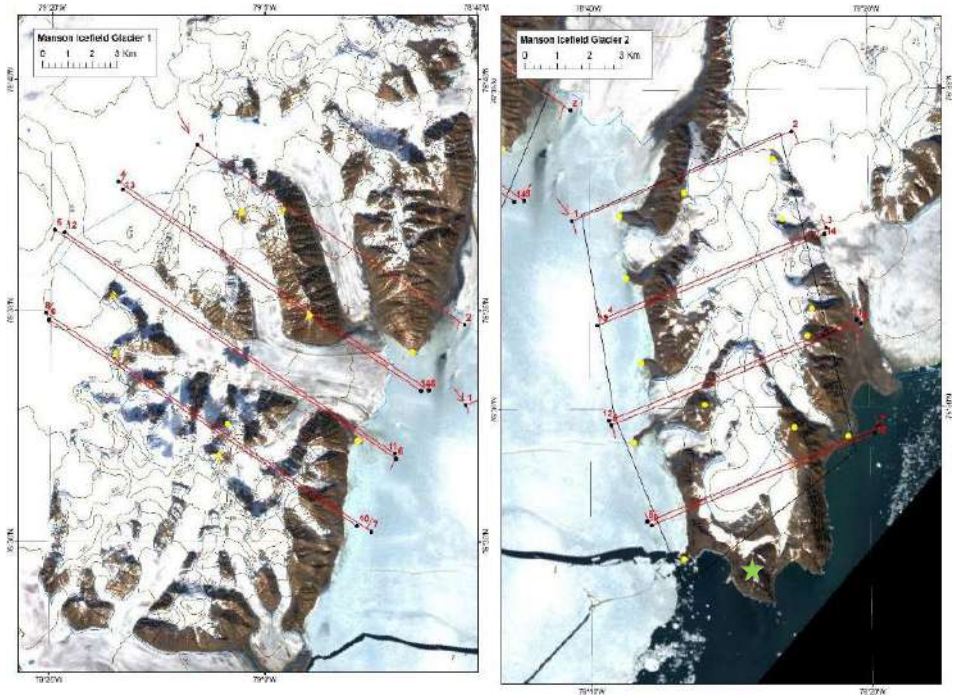

Figure 3-9 Map of the actual photo survey flight lines on SE Manson Icefield. Manson 1 survey (left), Manson 2 survey (right) where the green star indicates the approximate location of the ground control point. Credit: Alison Cook.

Prior to the surveys we secured our GPS unit, antenna and our camera tripod in the helicopter to be able to fly with the rear door open to take pictures (Figure 3.10). We also gave the helicopter pilot in advance the coordinates of the planned flight lines as well as the required altitude (between 5000 and 6000 ft) and speed (±81 knots). The original intention was to repeat twice each flight lines (as presented in the maps of Figure 3.8 and Figure 3.9) to maximize the number of pictures but due to time constraints we flew each line once. Our team decided it was best to

get multiple different surveys than to take extra precautions for only one survey. Our survey flight time was then reduced by half to ~30 minutes for the Devon Ice Cap and ~20 minutes each for both Manson Icefield surveys.

Figure 3-10 Set-up of the camera (Nikon D850) and differential GPS (Trimble R7 in yellow box) in the helicopter (left) and example of photo from Manson 2 survey that will be used to create the DEMs (right). Photos: Abigail Dalton and Claire BGM.

We encountered some problems with our differential GPS unit during our first survey on Manson Icefield where it was not recording the position every time a photo was taken. This information is crucial to create the DEMs so we repeated the one flight line were we noticed the problem (Manson 1 survey has 5 flight lines instead of 4 and the highest number of pictures). Unfortunately, this problem persisted during the Manson 2 survey and we suspect it was due to the speed of transmission of the information in the cables and not due to a hardware problem that we could have solved rapidly. Due to the piston core activities on the ship, we had the time to set up a ground control point with a fixed GPS for one hour in the footprint of the Manson 2 survey to help in the validation of the position of our photos (Figure 2.11). Overall, we judge our photo survey work to have been successful with the completion of 3 surveys in good light conditions with a very tight schedule on the ship while transiting up to Eastern Ellesmere Island.

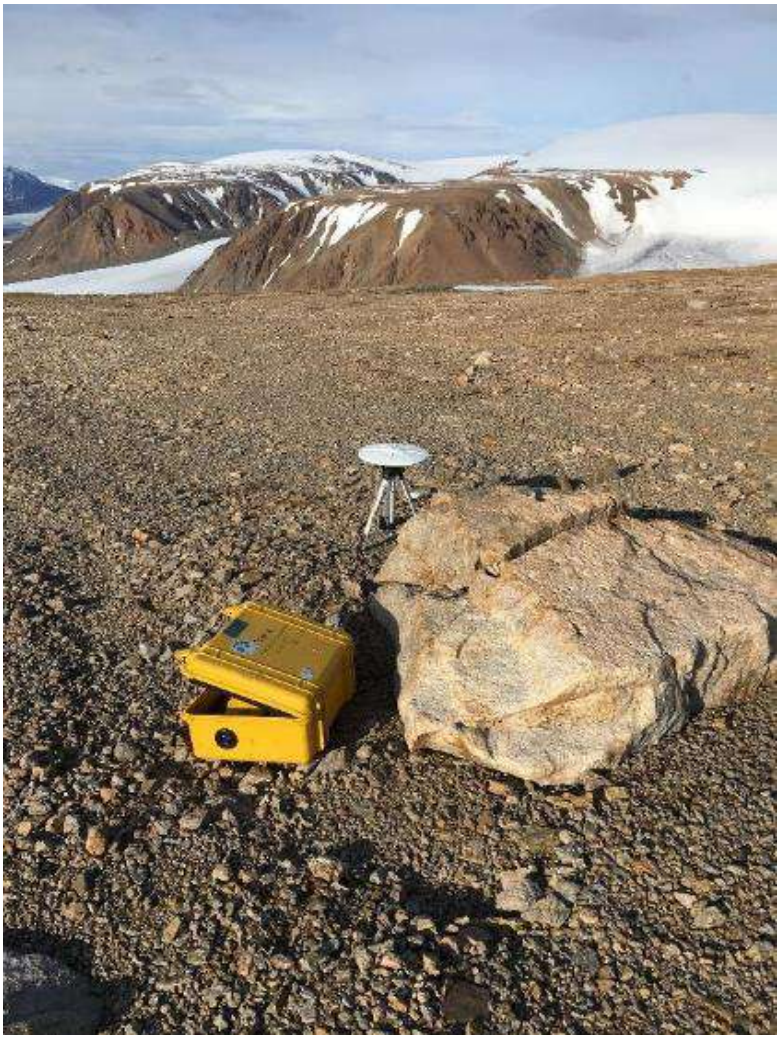

Figure 3-11 Trimble R7 GPS unit set-up near a boulder in the footprint of the Manson 2 survey (see green star in Figure X2). Photos: Claire BGM.

3.3 Preliminary results

Shown above in Figure 3.3 is a track of an ice island fragment tagged off SE Ellesmere Island. Results show that is has drifted in a looping pattern since being deployed. Most results will only be known at a later time once the newly deployed iceberg trackers have been followed for several months. The photos to create high resolution DEMs will be processed by Alison Cook in the fall.

Reference

Van Wychen, W., Davis, J., Burgess, D.O., Copland, L., Gray, L., Sharp, M. and Mortimer, C. (2016) Characterizing interannual variability of glacier dynamics and dynamic discharge (1999-2015) for the ice masses of Ellesmere and Axel Heiberg Islands, Nunavut, Canada. Journal of Geophysical Research – Earth Surface, 121, doi: 10.1002/2015JF003708

4 Seabird and Marine Mammal Surveys – Leg 2c

Project leader: Holly Hogan[1] (holly.a.hogan@gmail.com)
Cruise participant – Leg 2c: Holly Hogan[1]
[1] *Canadian Wildlife Service, Department of Environment and Climate Change Canada*

4.1 Introduction

Seabirds are an integral part of marine ecosystems; their distribution is influenced by biological, chemical and physical oceanography. Changes in seabird distribution can therefore be an indicator of oceanographic variability. It is critically important to monitor seabird abundance and distribution patterns in the arctic, in order to monitor changes that are happening in response to the rapid environmental changes induced by global warming. Collecting data in the remote regions of the arctic is extremely expensive and all opportunities to fill data gaps are very important. Seabird data collected since 1980 show population trends for significant seabird colonies in the Canadian arctic (Gaston et al. 2009), including Thick-billed Murres and Northern Fulmars. Thick-billed Murre populations are apparently stable, but this species relies heavily on the sea ice-dependent Arctic Cod during the breeding season. Changes in sea ice and therefore prey availability may become a serious issue for this species in the future, potentially effecting population size and distribution throughout the eastern North Atlantic. Northern Fulmars have been in steady decline over the last decade. Data on breeding colonies and at-sea distribution is required to understand this decline.

4.2 Methodology

4.2.1 *Seabirds*

Seabird surveys were conducted using a standardized fixed-width survey area over a 900 scanning arc as per the Environment Canada Seabirds at Sea (ECSAS) protocols (Gjerdrum et al. 2012). These protocols were developed in a manner that is compatible with methods used by north Atlantic European countries. Surveys are conducted by the by the Canadian Wildlife Service (CWS), Department of Environment and Conservation Canada to address management and conservation responsibilities under the Migratory Bird Convention Act (MBC Act 1996). The Canadian Wildlife Service places seabird observers on multiple ships of opportunity throughout the year. Data are consolidated, summarized and analyzed from a central database maintained by the Atlantic Region office in Dartmouth, Nova Scotia. The data are open and shared with other departments and jurisdictions.

These data provide important information on pelagic seabird distribution throughout the year, including patterns of dispersal from breeding areas, migration routes and wintering areas. Over time, these data show not only patterns of dispersal, but also trends in species abundance, diversity and distribution. This information will therefore help inform decisions regarding protecting sensitive marine areas, environmental assessment of proposed development projects and appropriate response to catastrophic events (e.g. oil spills).

One thousand one hundred and sixty five 5-minute survey watches were conducted during the expedition, representing ninety seven survey hours. A complete list of species observed is given in Table 4.1. Summary statistics and distribution maps will be provided by CWS in a timely manner upon return.

4.2.2 *Marine Mammals*

Marine Mammal surveys are conducted using protocols involving multiple observers, covering a 1800 arc at an infinite distance. There was neither the manpower nor expertise onboard to fulfill these requirements. However, marine mammal data were collected opportunistically; primarily during seabird survey efforts. Marine mammal observations made outside of seabird surveys were added to the database as "incidental observations". All marine mammals seen by the seabird observer or other person on the bridge were recorded in the ECSAS database. Species identity was confirmed by the seabird observer prior to data entry. Coverage was incomplete and likely underestimates marine mammal species composition and abundance. A far more complete picture of marine mammal temporal abundance will be provided by the acoustic data. It should be noted that in the Labrador Sea along the Greenland continental shelf there was a large concentration of cetaceans, including over 20 large baleen whales and 20 Long-finned Pilot whales. At least some of these appeared to be associated with an ocean front. All species observed are listed in Table 3.1.

4.3 Preliminary results

Table 4-1 Observed Seabird and Marine Mammal Species List

Species			
Seabird		Marine Mammal	
Common Name	Scientific Name	Common Name	Scientific Name
Common Eider	*Somataria mollisima*	Cetaceans	
Northern Fulmar	*Fulmarus glacialis*	Fin Whale	*Balaenoptera borealis*
Great Shearwater	*Puffinus gravis*	Sei Whale	*Balaenoptera physalus*
Ivory Gull	*Pagophila eburnea*	Long-finned Pilot Whale	*Globicephala melas*
Sabine's Gull	*Xema sabini*	Harbour Porpoise	*Phocoena phocoena*
Black-legged Kittiwake	*Rissa tridactyla*	Narwhale	*Monodon monoceros*
Lesser Black-backed Gull	*Larus fuscus*	Seals	
Great Black-backed Gull	*Larus marinus*	Harp Seal	*Pagophilus groenlandicus*
Herring Gull	*Larus argentatus*	Hooded Seal	*Csystophora cristata*
Iceland Gull	*Larus glaucoides*	Ringed Seal	*Pusa hispida*

Glaucous Gull	*Larus hyperboreus*		
Red Phalarope	*Phalaropus fulicaria*	Polar Bear	*Ursus marinus*
Red-necked Phalarope	*Pagophila lobatus*		
Arctic Tern	*Sterna paradisaea*		
Pomarine Jaeger	*Stercoracarius pomarinus*		
Parasitic Jaeger	*Stercoracarius parasiticus*		
Long-tailed Jaeger	*Stercoracarius longicaudus*		
Thick-billed Murre	*Uria lomvia*		
Black Guillemot	*Cepphus grylle*		
Dovekie	*Alle alle*		

Reference

Gaston, A.J., D.F. Bertram, A.W. Boyne, J.W. Chardine, G. Davoren, A. W. Diamond, A. Hedd, W.A. Montevecchi, J.M. Hipfner, M.J.F. Lemon, M.L. Mallory, J-F Rail, and G.J. Robertson. 2009. Changes in Canadian seabird populations and ecology in relation to changes in oceanography and food webs. Environ. Rev. 17: 267-286

Gjerdrum, C., D.A. Fifield, and S.I. Wilhelm. 2012. Eastern Canada Seabirds at Sea (ECSAS) standardized protocol for pelagic seabird surveys from moving and stationary platforms. Canadian Wildlife Service Technical Report Series No. 515. Atlantic Region. vi + 37 pp.

5 BaySys Mooring Operations in Hudson Bay – Leg 1

Project leaders: Jens Ehn[1] (jens_ehn@umanitoba.ca) and CJ Mundy[1]
Cruise participants – Leg 1: Sergei Kirillov[1]; Keesha Peterson[1]; Yanique Campbell[1]
[1] Centre for Earth Observation Science, University of Manitoba, Winnipeg, MB, Canada

5.1 Introduction

The initial cruise plan intended the recovery of five BaySys moorings deployed in the Hudson Bay in September 2016 (NE01 and JB02) and in October 2017 (NE02, NE03 and AN01). The change of cruise plan due to several SAR operations and heavy ice conditions in the central and southern parts of Hudson Bay did not allow us to reach the position of JB02 mooring at the mouth of James Bay. Two separate components of NE01 mooring deployed at ~30 m depth in the inner Nelson estuary zone were also not recovered. Although we were able to communicate with both acoustic releases, all our attempts to release the CT-line from the anchor and recovery pod from the bottom mount (Figure 5.1) failed. Later, the subsurface float from the CT-line was found nearby on the shoreline during one of the reconnaissance helicopter flight. Taking into account that float was initially located at ~20 m depth, we suggest that deep ice keels could have caused the damage of that mooring. Such deep keels could be associated with large stamukhi which were formed in the Nelson region due to the extremely strong tidal dynamics resulting in ice piling at the edge of landfast ice.

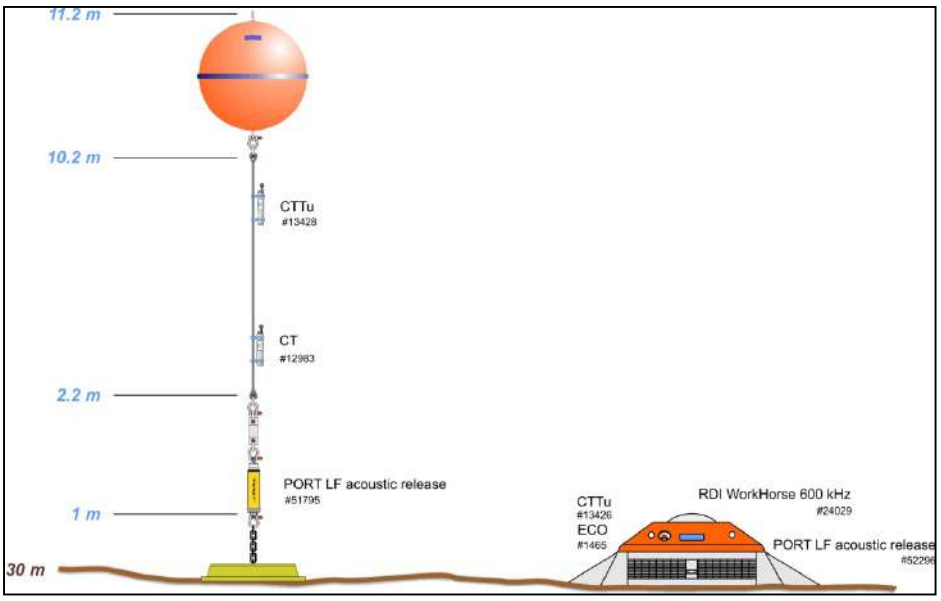

Figure 5-1 The configuration of the lost mooring NE01

Three other moorings deployed in October 2017 were successfully recovered in June 18, 25 and 28 (Table 5.1). The zodiac was used at every recovery station to draw the mooring line to the ship (Figure 5.2) for further lifting with a capstan and A-frame from the foredeck.

Table 5-1 The positions of recovered, deployed and short-term moorings

Date	CTD cast	Mooring ID	LAT (N)	LON (W)	Operation	Time (UTC)	Water depth (m)
05-juin	AM18-015	CMO-C	63º 11.001’	081º 58.873’	Mooring deployment	13:30	194
06-juin	AM18-H06	Ice-tethered setup	62.2815º	85.9543º	Mooring deployment	15:15	
06-juin	AM18-H07	Ice-tethered setup	62.2592º	85.8273º	Mooring deployment	22:00	
08-juin	AM18-018	CMO-D	63º 42.760’	088º 25.583’	Mooring deployment	12:30	119
12-juin	AM18-H24	Ice-tethered setup	62.4396º	85.3650º	Mooring recovery	15:30	
12-juin	AM18-H25	Ice-tethered setup	62.4595º	85.5283º	Mooring recovery	18:45	
16-juin	AM18-029	CMO-B	61º 45.613’	084º 18.172’	Mooring deployment	09:00	179
18-juin	AM18-031	NE02	57º 29.907’	091º 48.250’	Mooring recovery	16:15	43
25-juin	No cast	NE03	57º 49.776’	090º 52.817’	Mooring recovery	12:45	53
25-juin	No cast	Wave buoy	57°30.15’	091°47.51’	Mooring deployment	18:00	43
28-juin	AM18-044	CMO-A	59º 58.610’	091º 56.422’	Mooring deployment	15:00	106
28-juin	AM18-044	AN01	59º 58.443’	091º 57.236’	Mooring recovery	15:30	105
01-juil	AM18-046	Wave buoy	57°30.15’	57°30.15’	Mooring recovery	21:40	43

Figure 5-2 Mooring recovery with an assistance of zodiac

5.2 Methodology

5.2.1 *Mooring Deployments*

Four moorings were deployed along the main shipping channels across Hudson Bay as a part of Environmental Observing system related to the Churchill Marine Observatory project. The positions of all these moorings are shown in Figure 5.3. All deployed moorings were equipped with similar instruments except CMO-C site where 2 sediment traps (at 63 and 167 m) and a SeaFET pH sensor (at 30 m) were added to the line (Figure 5.4, Figure 5.5). The sediment trap motors were turned on at exactly 20:00 UTC on 4 June 2018 (interval 0) and they would begin rotating the carousel in 48 hours with a 36 day interval between rotations.

The following set of standard instruments was used for each mooring:

- Ice Profiling Sonar (IPS5) at 30 m;
- Acoustic Doppler Current Profiler (WH300 Sentinel ADCP) at 60 m;
- Acoustic Zooplankton Fish Profiler (AZFP). The depth of units varied from 75 to 90 m at different moorings;
- a broadband underwater acoustic recorder (TR-ORCA) deployed in between 80 and 150 m depth;
- Wetlab ECO triplet logger (measuring turbidity, chlorphyll-a and CDOM fluorescences) at 30 m;
- 3 SBE37 CTD (conductivity-temperature-depth) sensors at 30 m, 60 m and near the bottom.

All instruments were programmed for about 15-months deployment with the planned recovery in the fall, 2019. All moorings were deployed anchor last from the foredeck using the A-frame (Figure 5.6).

Figure 5-3 Positions of CMO moorings deployed in the Hudson Bay in June 2018

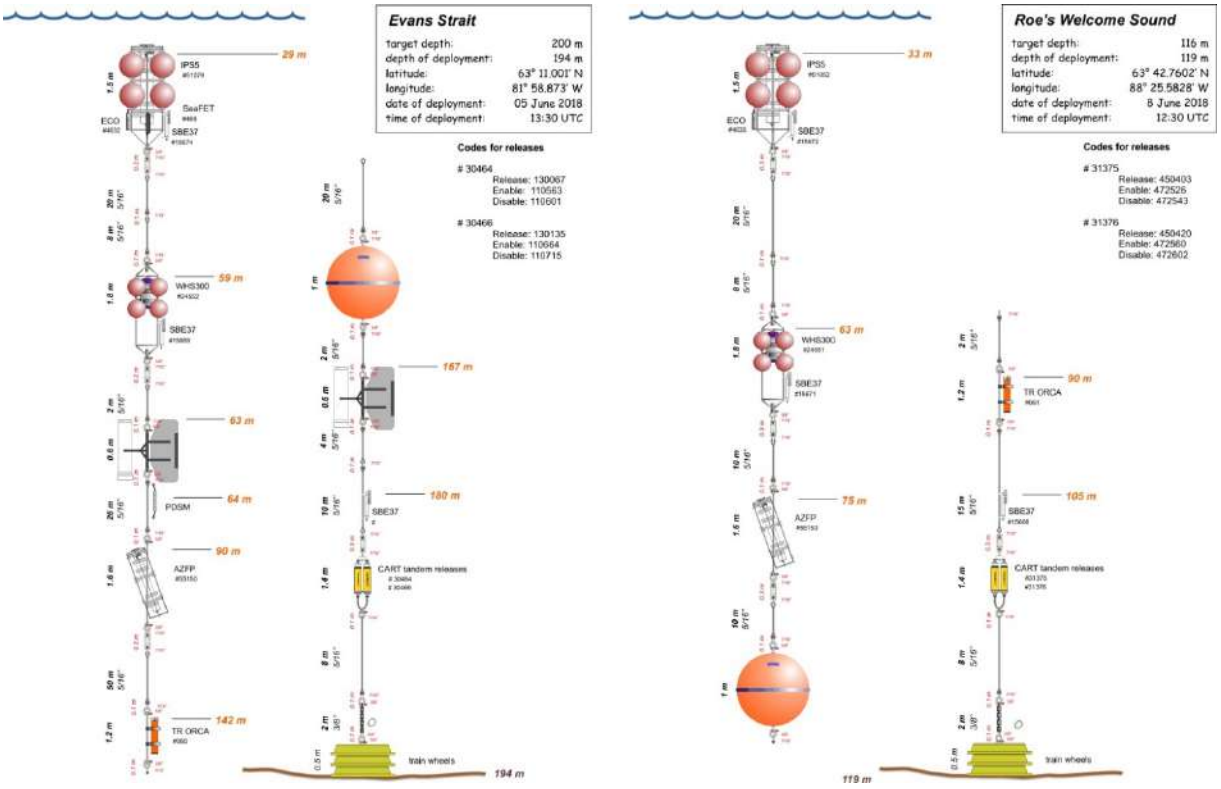

Figure 5-4 The configuration of CMO-C (Evans Strait) and CMO-D (Roes Welcome Sound) moorings

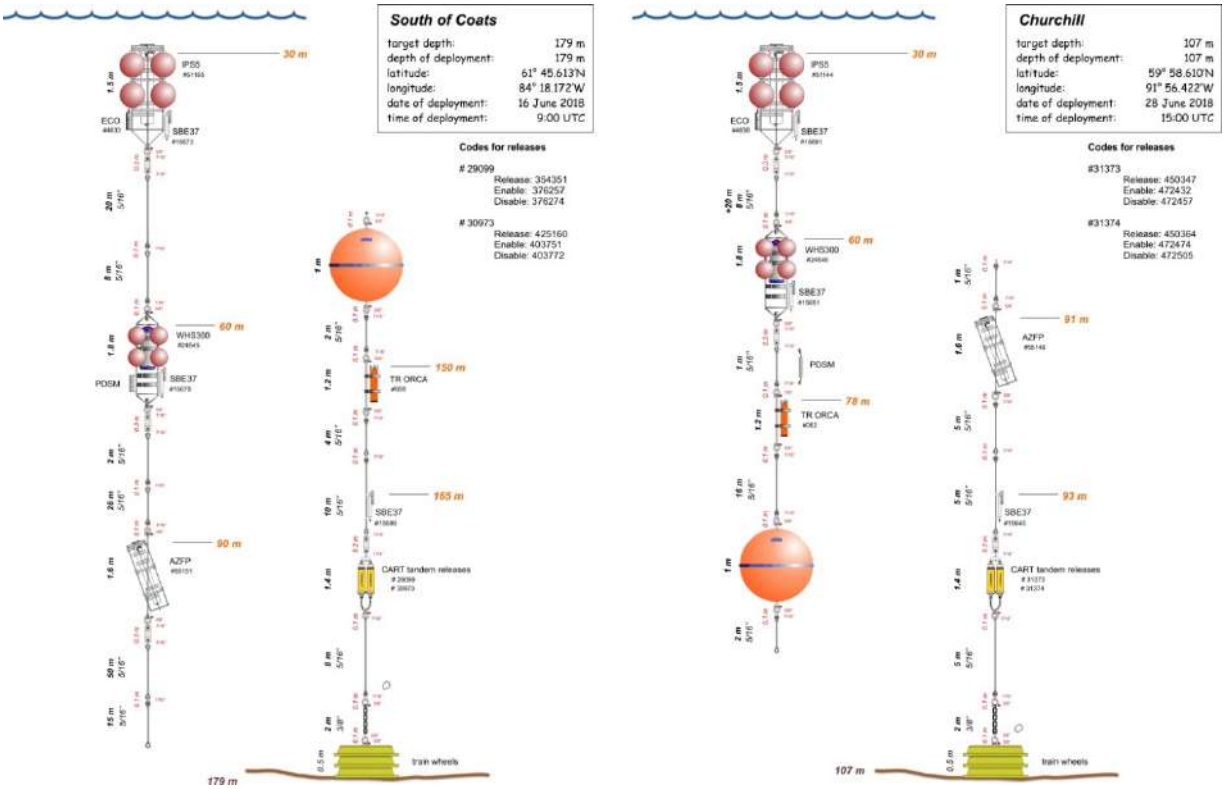

Figure 5-5 The configuration of CMO-B (South of Coats) and CMO-A (Churchill) moorings

Figure 5-6 Anchor last mooring deployment from the foredeck

5.2.2 *Short-Term Moorings*

Three short-term moorings were deployed during Leg 1. Two of them were ice-tethered setups that included a line of RBR CT sensors mounted between 2 and 14 meters, an upward looking Aquadopp 600 kHz ADCP at 13 m, and a GPS beacon (Figure 5.7). The eastern mooring was additionally equipped with a basic meteorological tower measuring air temperature, pressure, wind speed and direction, and sea ice thickness.

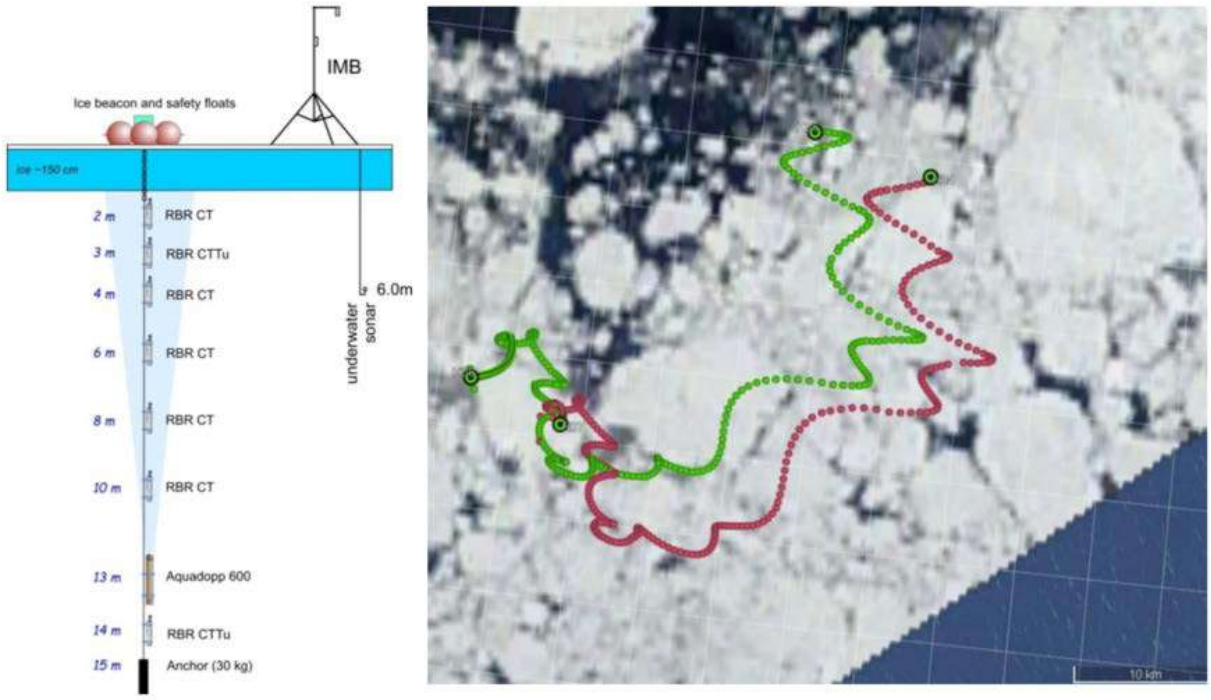

Figure 5-7 The configuration of the ice-tethered moorings and their trajectories between June 6 and 12

In the Nelson estuary region, a TRIAXYS wave buoy equipped with g3 sensor was deployed between June 25 and July 1 to measure the directional pattern of surface waves. The deployment took place at the beginning of a period of high winds (>10 m/s) over the region that persisted for several days. The objective of the wave buoy was to capture storm wave conditions in the region as a function of wind and the fetch distance created by the ice edge that was receding to the east. The growth and propagation of waves as a function of these parameters will be assessed. In addition, temperature and salinity data in the upper few metres will supplement the wave measurements, allowing for insight into wind-wave mixing in the mixed layer.

The synchronous measurements carried out with Nortek Signature 500 ADCP that was deployed at TRIAXYS site at 30 m depth is aimed to validate and compare TRIAXYS and ADCP records to each other. Figure 5.8 shows the diagram of experimental setup.

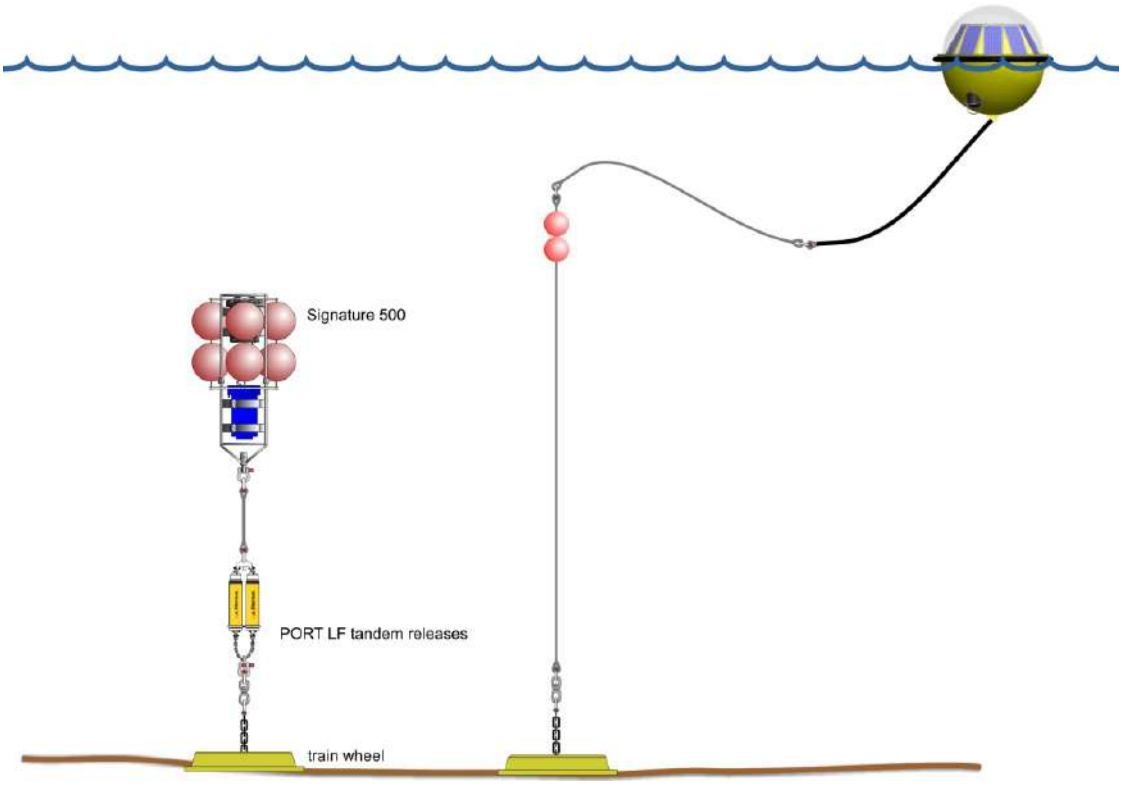

Figure 5-8 TRIAXYS wave buoy and Signature 500 ADCP setup for the wave measurements in the Nelson region

5.3 Preliminary Results

Data from all instruments was examined after recovery to determine if all equipment worked properly and recorded reliable data. We also examined the pressure records from all available sensors to adjust the depths of moored instruments and prepared the final schemes for the moorings' configurations (Figure 5.3). In general, all recovered instruments worked well and 8-month time series of temperature, salinity, current velocities, ice thickness/waves etc. were correctly recorded (Table 5.2).

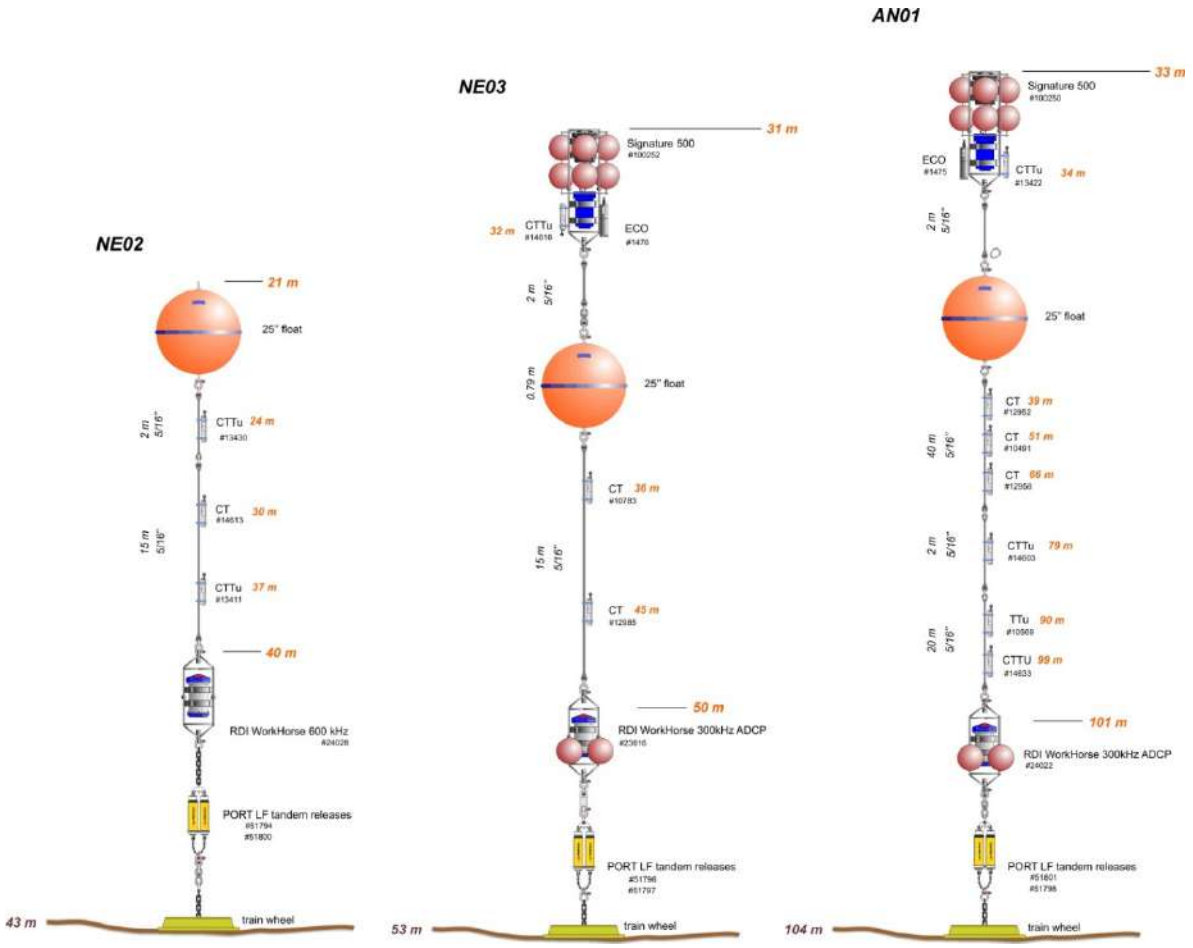

Figure 5-9 NE02 (Nelson Outer Estuary), NE03 (Nelson River outer shelf) and AN01 (Churchill shelf), mooring configurations as recovered

Table 5-2 Status of data at recovered moorings

Mooring	Instrument	Depth (m)	Start time	End time	Period	Data status	Notes
NE02	WH600	40	29 Oct, 2017	18 Jun, 2018		OK	
	RBR CTTu	24	29 Oct, 2017	18 Jun, 2018	15 min	OK	
	RBR CT	30	29 Oct, 2017	18 Jun, 2018	15 min	OK	
	RBR CTTu	37	29 Oct, 2017	18 Jun, 2018	15 min	OK	
NE03	Signature 500	31	29 Oct, 2017	25 Jun, 2018		OK	
	WH300	50	29 Oct, 2017	25 Jun, 2018		OK	
	ECO	32	29 Oct, 2017	25 Jun, 2018	30 min		Not retrieved yet
	RBR CTTu	32	29 Oct, 2017	25 Jun, 2018	15 min	OK	
	RBR CT	36	29 Oct, 2017	25 Jun, 2018	15 min	OK	
	RBR CT	45	29 Oct, 2017	25 Jun, 2018	15 min	OK	
AN01	Signature 500	33	1 Nov, 2017	28 Jun, 2018		OK	
	WH300	101	1 Nov, 2017	28 Jun, 2018		OK	
	ECO	34	1 Nov, 2017	28 Jun, 2018	30 min		Not retrieved yet
	RBR CTTu	34	1 Nov, 2017	28 Jun, 2018	15 min	OK	
	RBR CT	39	1 Nov, 2017	28 Jun, 2018	15 min	OK	
	RBR CT	51	1 Nov, 2017	28 Jun, 2018	15 min	OK	

	RBR CT	66	1 Nov, 2017	28 Jun, 2018	15 min	OK	
	RBR CTTu	79	1 Nov, 2017	28 Jun, 2018	15 min	OK	
	RBR TTu	90	1 Nov, 2017	28 Jun, 2018	15 min	OK	
	RBR CTTu	99	1 Nov, 2017	28 Jun, 2018	15 min	OK	

6 ArcticNet Mooring Program Report – Legs 2c, 3 and onboard the CCGS *Sir Wilfrid Laurier*

Project leader: Louis Fortier[1] (louis.fortier@bio.ulaval.ca)
Cruise participants – Leg 2c: Shawn Meredyk[1] and Thomas Linkowski[1]
Cruise participants – Leg 3: Shawn Meredyk[1], Luc Michaud[1] and Alexandre Forest[1]
Cruise participants – *Sir Wilfrid Laurier*: Shawn Meredyk[1], Greg Curtiss[2] and David Hurley[3]
[1] *Amundsen Science, Université Laval, Québec, Qc, Canada*
[2] *Golder Associates Ltd., Seattle, WA, United-State*
[3] *Golder Associates Ltd., Vancouver, BC, Canada*

6.1 Introduction

6.1.1 *Mooring Program Objectives*

Sampling year 2018 was part of a summer-fall campaign involving three legs and two support vessels (*Amundsen* amd *Laurier*), studying the air-sea interactions, underwater sound ecology, ocean circulation variability and shelf-basin sediment interactions in the Labrador Sea, NE Baffin Bay, Queen Maud Gulf, Amundsen Gulf and southern Beaufort Sea.

Mooring operations (HiBioA, HiBioB) during Leg 2c (July 24 – August 16) were financed by DFO and recovered and redeployed HiBioA along with a new mooring HiBioB. HiBioA-18 was deployed at 1020m while HiBioB-18 was deployed at 1983m. This shelf-basin mooring array should provide sufficient baseline data for the establishment of a new Marine Protected Area (MPA) in the Labrador Sea off-shelf Hatton Basin.

Mooring operations during leg 3 (August 17 – September 7) saw the recovery of the ArcticNet – Parks Canada – Weston Foundation mooring (WF1) and Baffin Bay LTOO moorings (BA06, BA05) which brings the two programs studying the bottom current rounding southern Greenland and the Queen Maud Gulf current regime, to an end.

Mooring operations between September 24 – October 16, onboard the *Laurier*, were part of the ArcticNet Long-Term Ocean Observatory (LTOO) project / and Integrated Beaufort Observatory (iBO; partly supported by the Environmental Study Research Fund (ESRF)). The LTOO moorings in Cape Bathurst Polynya are a continuation of the LTOO dataset studying these nutritive waters. The iBO mooring sites are based on key locations identified by the Southern and Northeastern Beaufort Sea Marine Observatories project funded under the former Beaufort Regional Environmental Assessment (BREA) (2011 to 2014). Mooring operations onboard the Laurier concerned the re-deployment of iBO-LTOO associated moorings maintained by the Institute of Ocean Sciences (IOS, Fisheries and Oceans Canada) and ArcticNet / Amundsen Science. The details of which can be found in the 2018 IOS-ArcticNet / Amundsen Science cruise report (DFO, 2018).

The total ArcticNet / Amundsen Science managed mooring operations, during leg 2 and 3 onboard the *Amundsen*, included four moorings recovered and two moorings that were

deployed in the Labrador Sea. During Leg 2c onboard the *Amundsen*, technical support was provided to the ATLAS project, investigating current models around SW Greenland. During Leg 3 onboard the *Amundsen*, a benthic lander / mooring was not recovered for Dr. P. Archambault (ULaval) in conjunction with the now defunct OceanLab in Edinburgh, Scotland. Additionally, mooring operations onboard the Laurier included two out of six mooring recoveries and zero mooring re-deployments in the Beaufort Sea and Amundsen Gulf due to extensive multiyear ice covering the mooring sites in early Autumn, which was unexpected.

6.1.2 *Mooring Arrays*

Baffin Bay

Moorings BA05 and BA06 form a small array near the Northern Open-water Polynya in the upper NE region of Baffin Bay. These mooring were deployed in 2016 and were re-deployed in 2017 to continue collecting data on the NSW Greenland benthic current. The recovered data (2018) will be used in current model validation by Dr. Danny Dumont (UQAR).

Beaufort Sea

The iBO moorings (BRG, BR1, BRK, BR3) helped form three shelf –slope arrays that examined the spatial variability in shelf-slope processes in the southeastern Beaufort Sea. These moorings continued a long-term integrated observation of ice, water circulation and particle fluxes established in the southern Beaufort Sea since 2002. Moorings BR1, BRG, BR3 and BRK were as part of the iBO program. Additionally, moorings DFO-1, DFO-2 and DFO-9 are included in the iBO program along with the MARES and other DFO moorings.

Amundsen Gulf

LTOO moorings CA08 and CA05, in the Amundsen Gulf, were deployed in 2017 to finalize the annual time-series collected in the area from 2002 to 2018. This region, also known as the “Cape Bathurst Polynya”, was previously identified as an area of increased biological activity due to an earlier retreat of sea ice in spring and frequent upwelling of nutrient-rich waters that develops along Cape Bathurst and near the eastern edge of the Mackenzie Shelf. Unfortunately, only mooring CA08 was recovered due to extensive multiyear ice cover over Site CA05, preventing recovery operations from the CCGS Sir Wilfred Laurier.

Queen Maud Gulf

Moorings WF1 and WF2 are moorings that are part of a combined effort by the Weston-Garfield Foundation, ArcticNet and Parks Canada deployed to study the oceanographic conditions near the Erebus and in the Queen Maud Gulf near the location of the wreck site. The Weston Foundation provided sufficient funding, with in-kind support from ArcticNet. ArcticNet and Parks Canada provided technical and operations support with the vessel support from the CCGS Amundsen / Sir Wilfred Laurier. Mooring WF1 was recovered in 112m of water in the Queen Maud Gulf.

WF2 was a benthic tripod (near the Erebus at 12m depth) with an upward looking ADCP (RDI Sentinel V) combined with an RBR CTD-Tu sensor and was unable to be recovered in 2018 due to ice complications and time constraints.

Labrador Sea

The HiBio moorings are part of a shelf – slope break mooring array started with HiBioA-17 and now includes HiBioA-18 and HiBioB-18 to examine the effects on invertebrate megafaunal settlement, marine mammal presence and shelf-slope carbon fluxes. The new mooring HiBioB was also equipped with a hydrophone and near bottom current profilers which will help answer questions about near-bottom sedimentation while listening for marine mammal activity. The HiBio project was created to collect baseline studies of the area and processes needed to help DFO make an informed decision as to where to place the Marine Protected Area (MPA) in this part of the Labrador Sea. Emphasis on benthic marine life and the processes governing them is the over-arching objective of this mooring.

Understanding how ecosystems function and interact is a major goal of ATLAS. ATLAS is developing a new suite of predictive models which integrate hydrodynamics, food availability, organism feeding ecology and ecophysiology to predict biomass and biogeochemical activity producing a step-change in the way in which we predict ecosystem functioning now and in the future. The models will predict how these ecosystems will adapt in a future of rapidly changing climate, carbon flux and deep ocean resource exploitation.

6.1.3 *Individual Mooring Objectives*

Moorings BRG-18 (700 m), BR3-18 (714m) weren't re-deployed due to extensive multiyear ice covering the sites, but are part of the ongoing effort to assess ocean circulation (the southern extent of the Beaufort gyre current near the Mackenzie Shelf), biogeochemical fluxes and sea ice motion and thickness distribution in key areas of the Mackenzie shelf-slope system (Figure 6.1).

Mooring HiBioA-18 (1020m) was redeployed at a deeper depth from its position at HiBioA along with new mooring HiBioB (1983m), ~20 nm east of HiBioA, as part of the continued HiBio mooring array investigating the effects on invertebrate megafaunal settlement, marine mammal presence and shelf-slope carbon fluxes for the eastern edge of Hatton Basin – Labrador Sea (Figure 6.1).

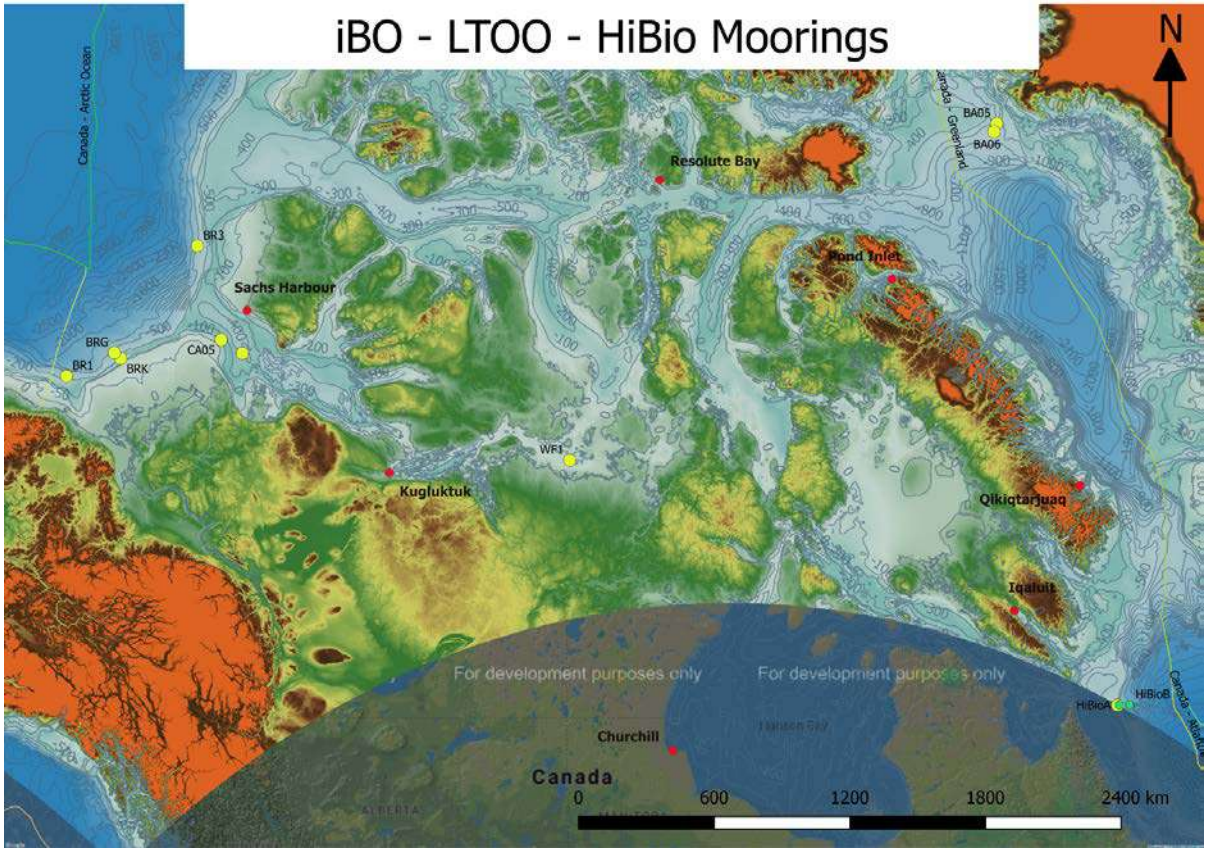

Figure 6-1 Mooring Locations 2017 (yellow) & 2018 (green): iBO, LTOO and Weston Moorings. Alternate iBO moorings DFO-1, DFO-2, and DFO-9 as well as other DFO moorings and MARES moorings are not provided in this report but can be found in the 2018 DFO/IOS Leg 3 Mission Report (DFO, 2018)

6.2 Methodology

6.2.1 *Mooring Designs*

Recoveries

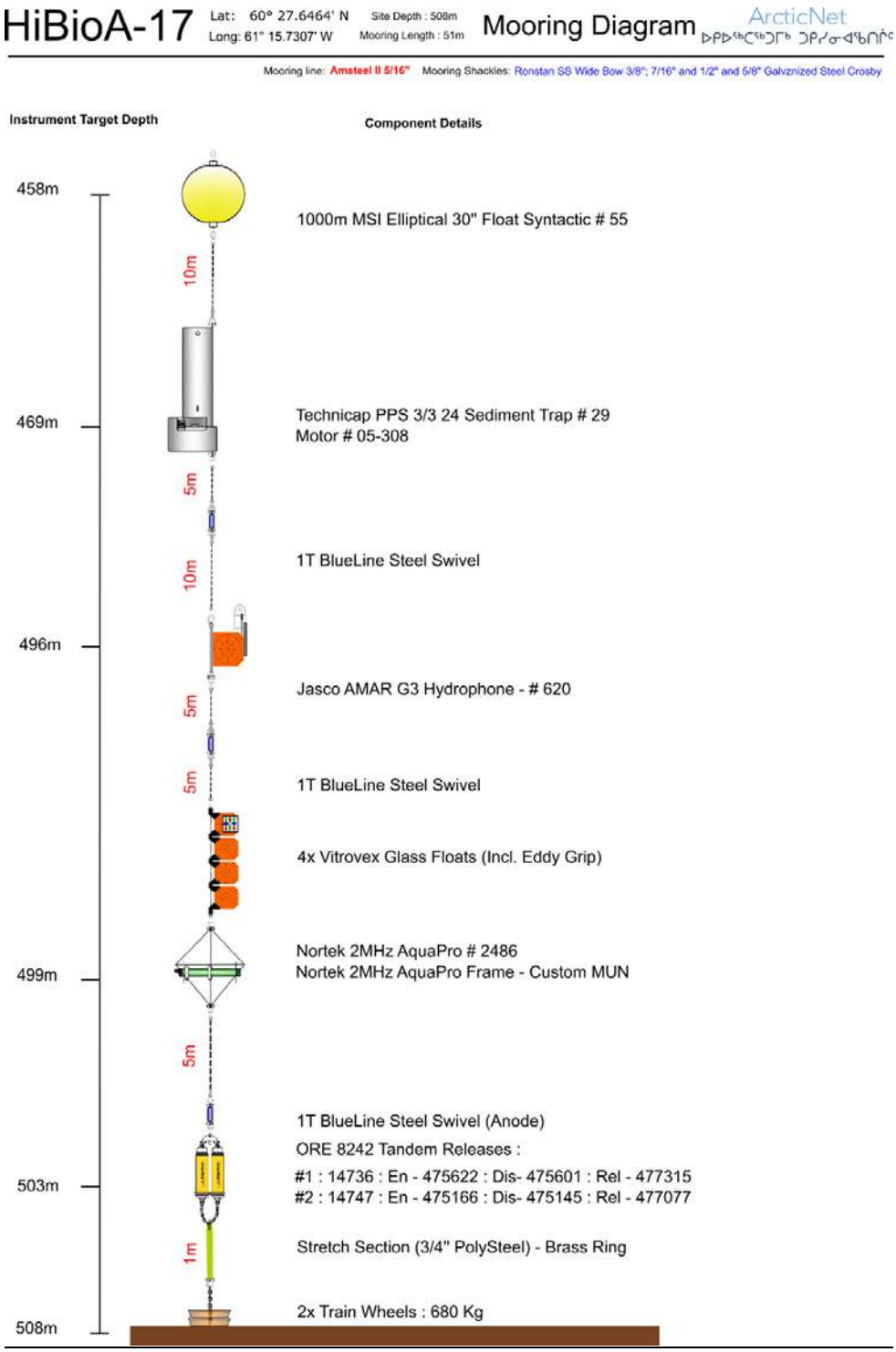

Figure 6-2 HiBioA-17 Mooring design

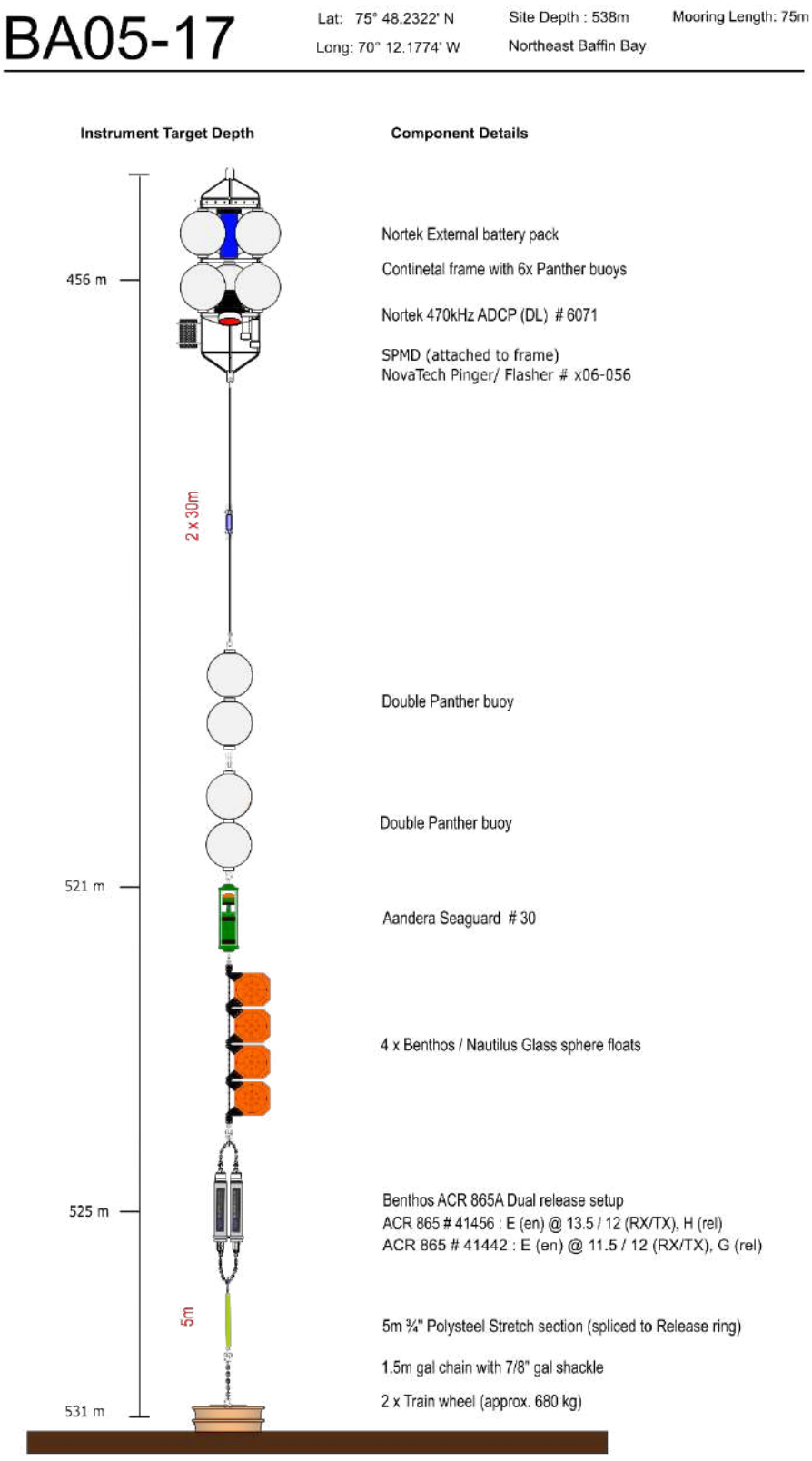

Figure 6-3 BA05-17 Mooring design

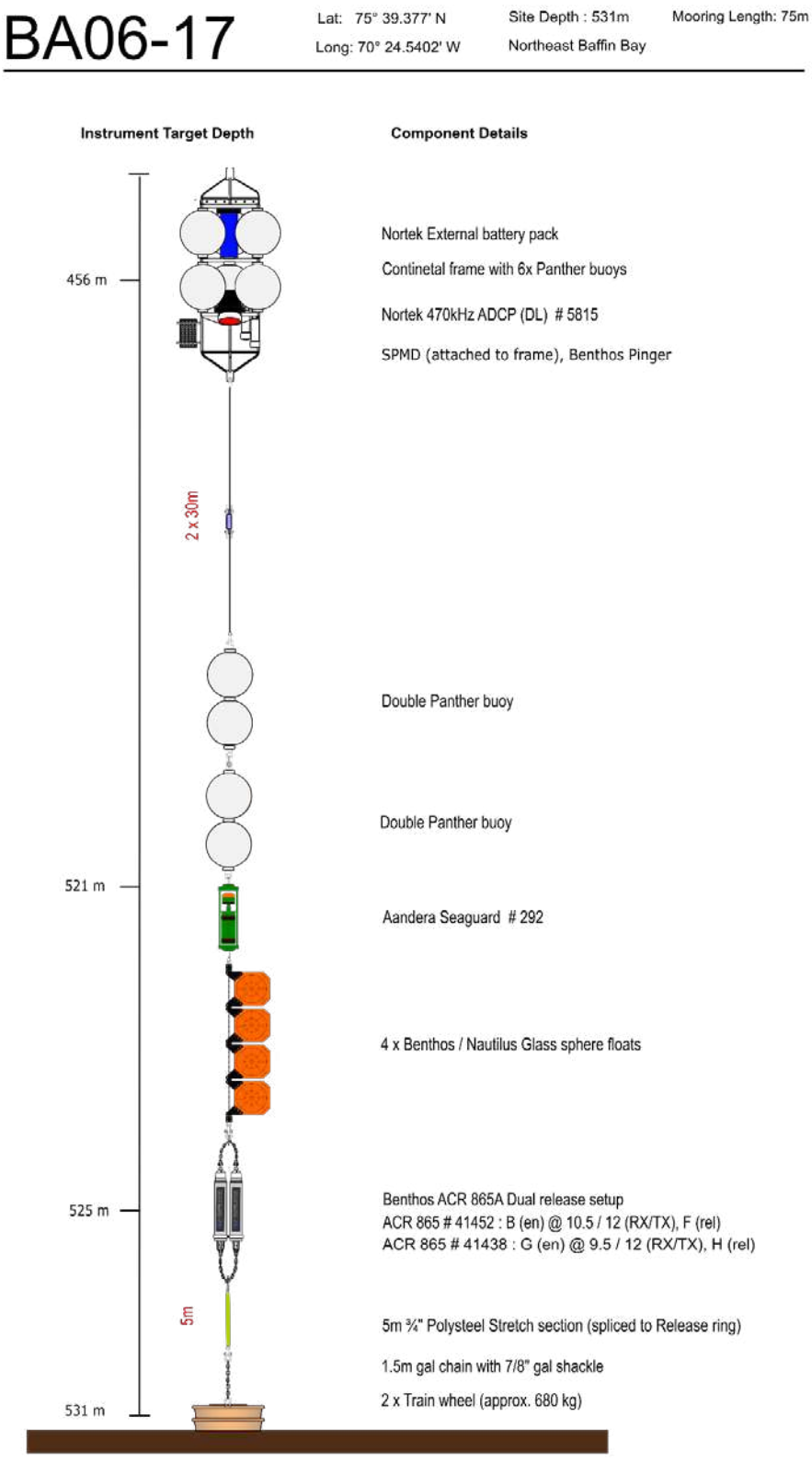

Figure 6-4 BA06-17 Mooring design

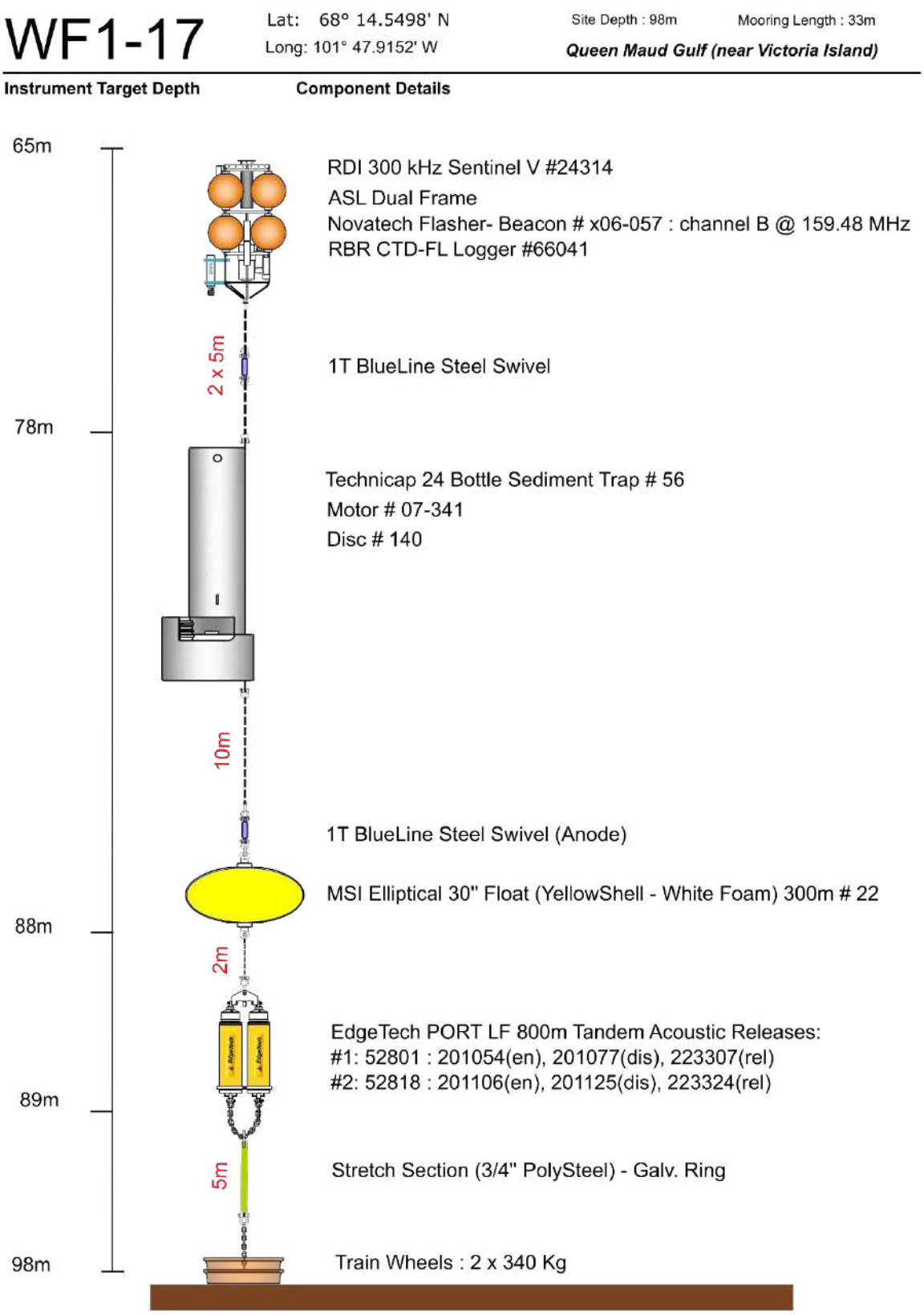

Figure 6-5 WF1-17 Mooring design

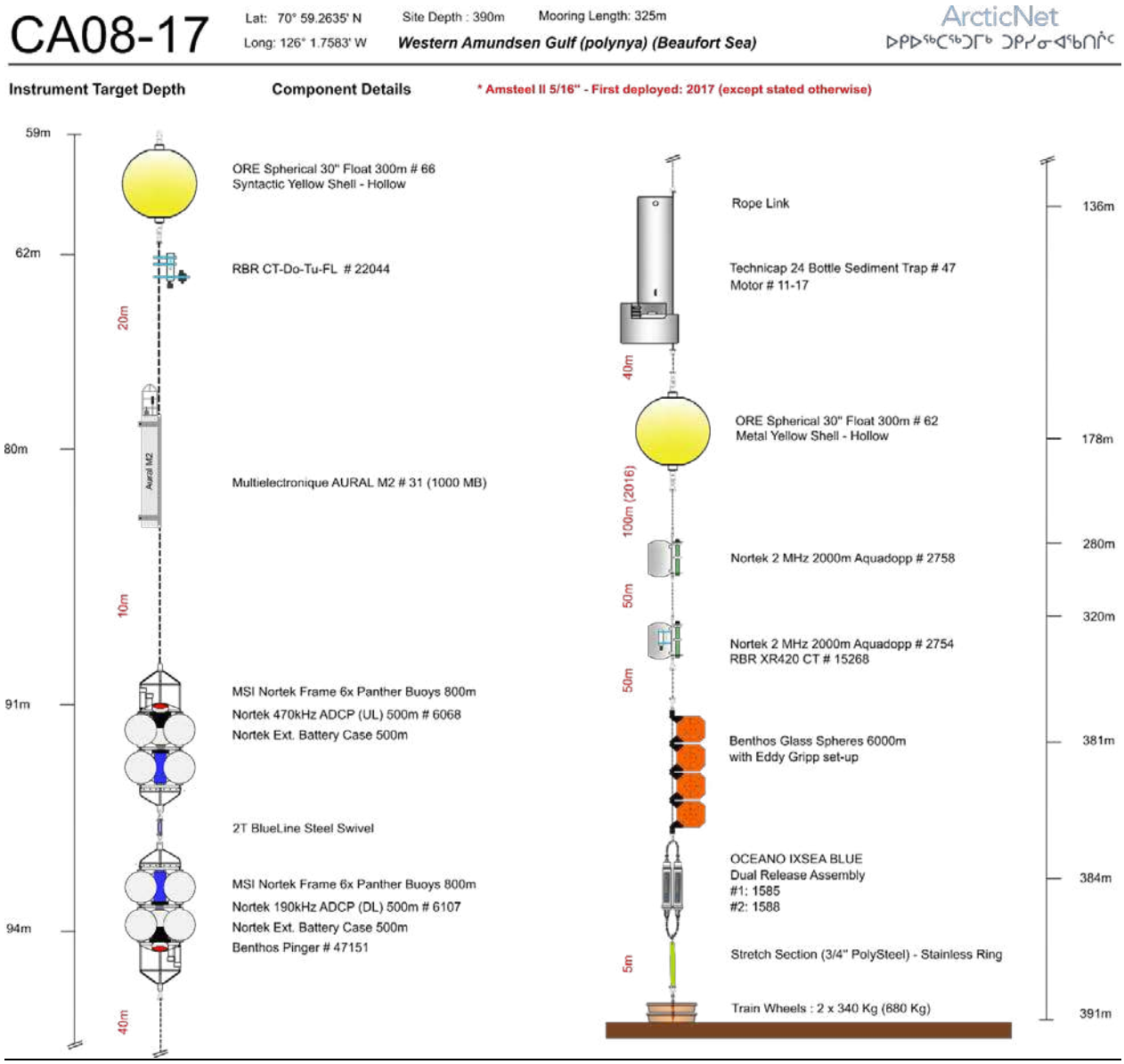

Figure 6-6 CA08-17 Mooring design

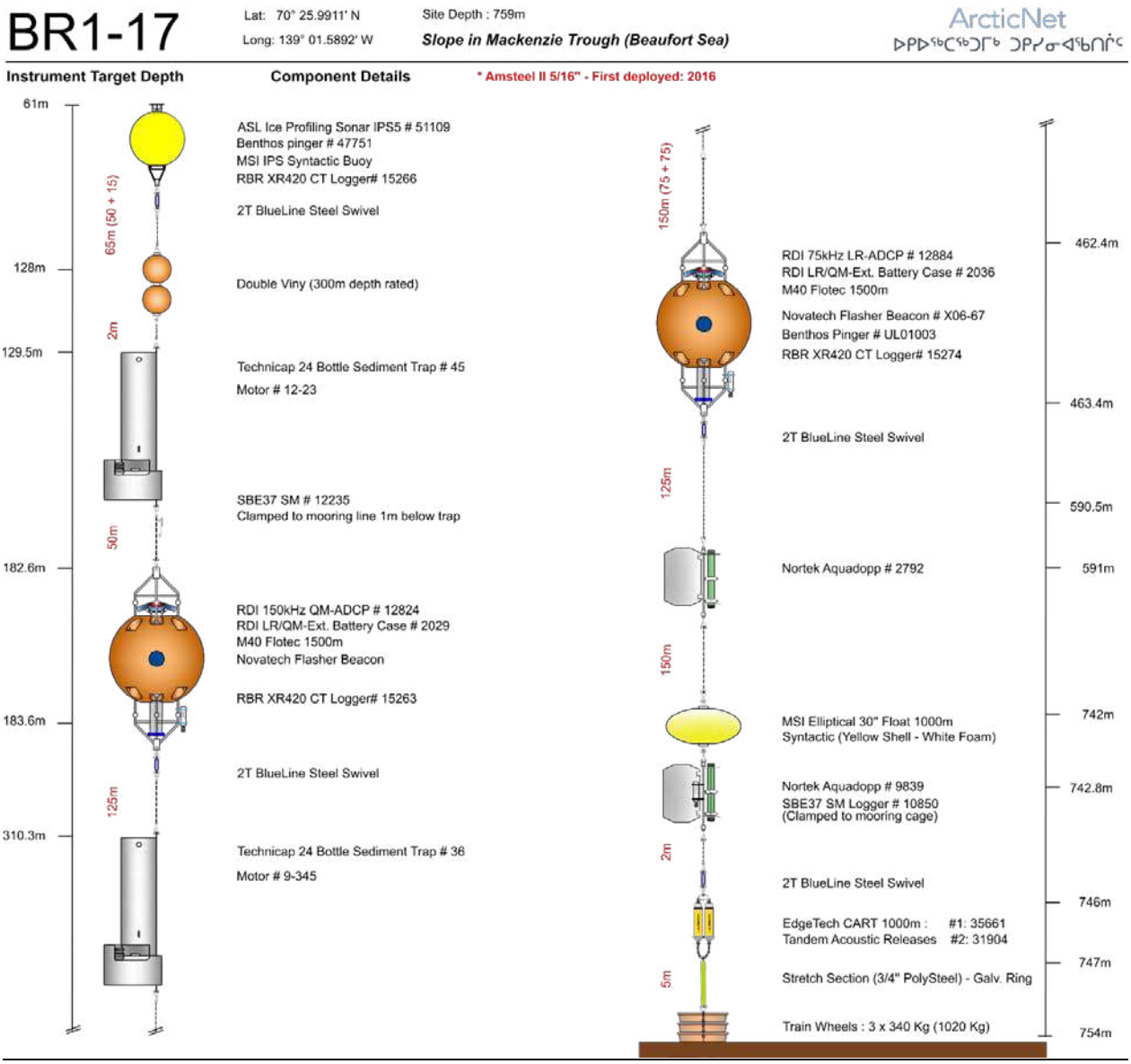

Figure 6-7 BR1-17 Mooring design

Deployments

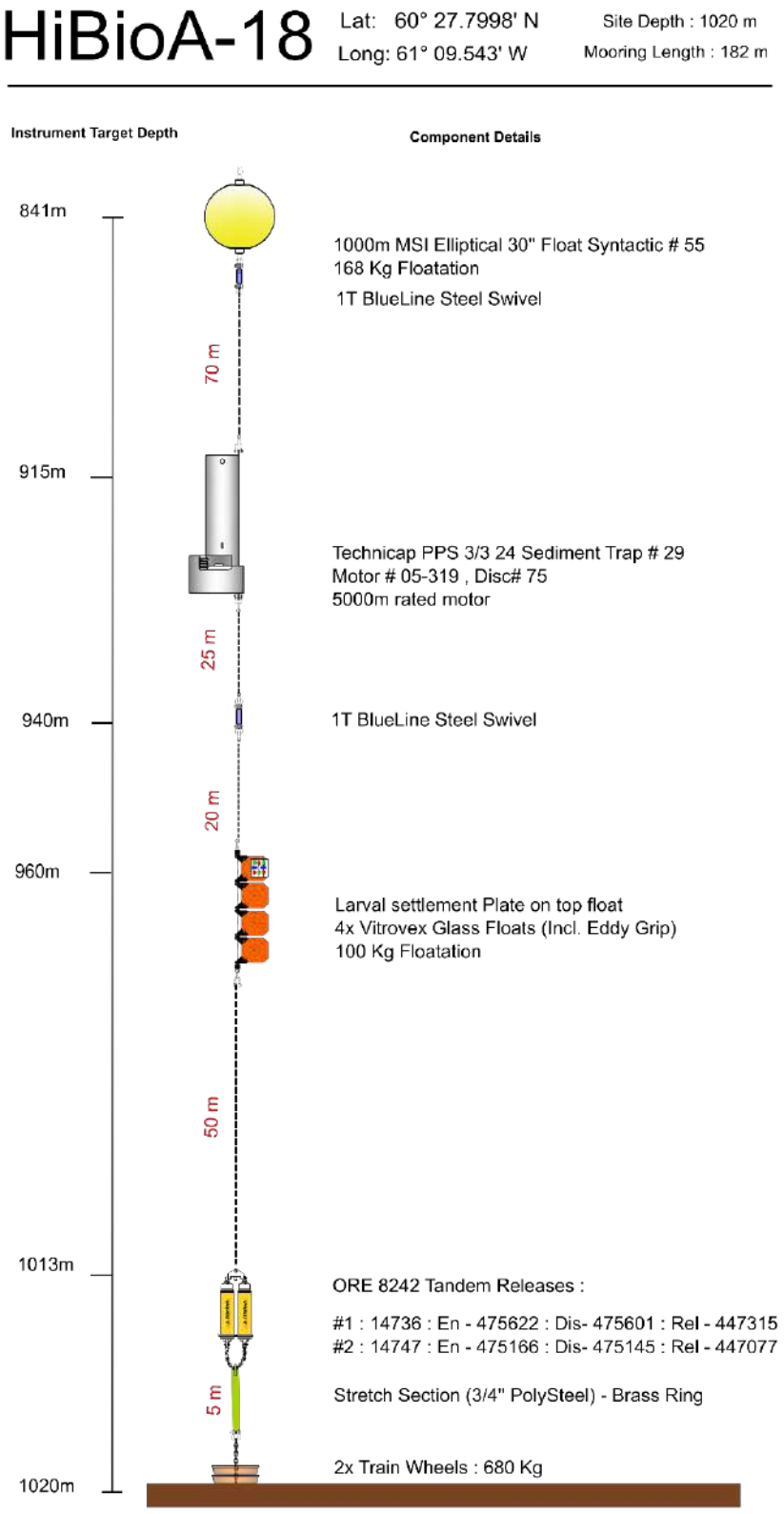

Figure 6-8 HiBioA-18 Mooring design

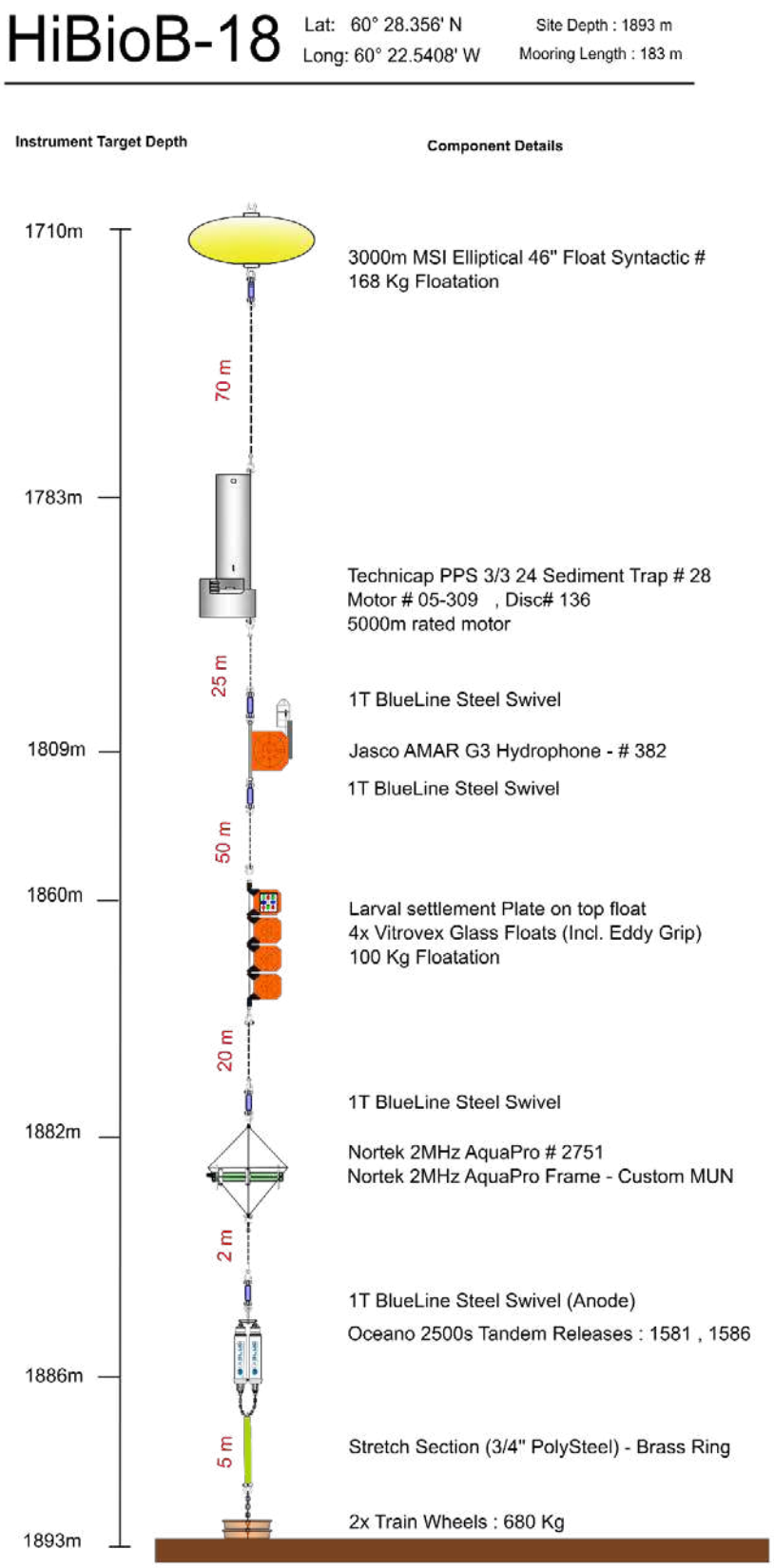

Figure 6-9 HiBioB-18 Mooring design

6.2.2 *2018 Mooring Recovery Summary*

Two out of six moorings from the Beaufort Sea (CA08, BR1) were successfully recovered using the CCGS *Laurier*. The ice conditions in the Amundsen Gulf and Beaufort Sea covered all other mooring sites than the two moorings that were recovered.

Onboard the *Laurier* the mooring operations are conducted by the deck crew in direct contact with the captain at the helm. Amundsen Science and Golder personal assisted as directed on-deck, primarily in the form of shackle removal and equipment displacement once on-deck. The recovered equipment was promptly placed into the top Hold (Between Decks Hold) to allow for safe and effective unstaging of the equipment.

The *Laurier* recovery operations were performed with a cabestan through a snatch-block (open pulley) over the deck rail. A deck fixed cable puller (Chicago / bulldog grip) was used to keep the water-side tension under control while the recovered instrument(s) were removed from the line. The line was then reconnected to the cabestan line and recovery operations continued as such just until the last buoy-aquadopp-release combination, which was lifted by a cable puller attached to the derrick 20T crane line (Figure 6.2).

Figure 6-10 Deck setup, showing the cabestan and snatch block locations for recoveries on the Sir Wilfred Laurier

All four moorings from the Eastern and Central Arctic (BA05, BA06, WF1, HiBioA) were recovered using the CCGS Amundsen. Benthic Mooring (Tripod) WF2 was unable to be recovered by Parks

Canada archeological Dive Team due to extensive multiyear ice cover over recovery sites and for a full record of the recovered moorings see Appendix 2 .

HiBioA-17 recovery was delayed for 2 days while waiting for the fog bank to lift. On July 29th, 2018 the mooring site was scanned via the multibeam system. The vertical nature and site confirmation at the expected depths was confirmed, though the fog bank prevented recovery for two days (Figure 13). Finally, on July 31st, 2018 HiBioA-17 was recovered. The old ORE 8242 acoustic releases on HiBioA didn`t send a message received signal, once enabled. Though a signal was sent once disabled or released. This was confusing at the moment of mooring release. But, the release signal did send an acknowledgement and the mooring did release on the first try (unit 14736).

The multibeam data identified the anchor at a site 200m SE from the deployed position (Figure 14). The cause of this displacement was not initially evident but from looking at the recovered data and LADCP data from the rosette, high benthic SE down welling currents were identified as the probable mechanism.

The mooring recovery required the use a supplementary lifting wire for the 5m rope section above the releases. The lift was facilitated by a cable puller / Bulldog grip. Both the releases and the 4 x Benthos glass spheres were lifted together and brought onboard without any problem.

6.2.3 *M ooring Deployment Summary*

Re-Deployement Summary

Mooring HiBioA was redeployed at a different position from its position from 2017. The new position is at 1020m down-slope from it`s 2017 position (508m). HiBioA-18 mooring was re-designed during the winter of 2018 to make deck operations safer and to get the sediment trap off-bottom in an effort to remove any resuspension bias within the sediment trap sample record. The design changes were approved by DFO (David Cote) and Len Zedel (MUN). Due to unknown reasons, replacement equipment was not available from DFO nor MUN, which leads to the on-site change that was necessary for HiBioA-18. The minor secondary change to the HiBioA mooring redeployment was a result of observed corrosion on the recovered Aquadopp profiling current meter mounting frame which was custom made at MUN in 2017 (Figure 6.3). Due to the highly corroded nature of the recovered current meter`s mounting frame, the decision to not redeploy the frame and run the risk of loosing the equipment or mooring was made by Len Zedel (MUN). Thus, HiBioA-18 was deployed without a current meter nor a hydrophone, where as HiBioB-18 included the full suite of planned equipment for the HiBio mooring program. DFO and MUN could make efforts to purchase replacement equipment which not only permits quick mooring turn-around but also permits adequate time to inspect equipment and frames throughout the winter.

Figure 6-11 HiBioA-17 Recovered Aquadopp Profiler frame corrosion

Deployment Summary

Two moorings were successfully deployed during Leg 2c onboard the Amundsen. The mooring deployments were delayed by heavy fog for several days, though eventually the weather got better and was possible to deploy the moorings. The zodiac was not used for the deployment of HiBioA-18, however, HiBioB-18 required the help of the zodiac due to difficult winds and surface currents affecting the Amundsen.

HiBioA-18 couldn`t be verified 100% by the multibeam imagery after a second multibeam pass directly over-head, thus a triangulation using the deckbox and ORE 8242 acoustic releases was needed. HiBioB-18 was verified vertical and with the expected depths on the second multibeam pass, thus a manual triangulation was needed nor performed.

Two benthic landers were also successfully deployed in the Labrador Sea (Saglek Bank) for the ATLAS program, onboard the Amundsen. The deployment of these landers required a great deal of help from the onboard Amundsen-Science mooring team and other benevolent scientists with time to spare. Efforts should be made by ATLAS to become more self-sufficient through adequate preparation for the 2019 mission.

Table 6-1 Mooring deployment summary

Leg	Mooring ID	Latitude	Longitude	Latitude (DD)	Longitude (DD)	Depth (m)
2c	HiBioA-18	60˚27.7893' N	61˚09.564' W	60.46316	-61.1594	1020
2c	HiBioB-18	60˚28.356' N	60˚22.5408' W	60.4726	-60.3757	1983

Mooring Deployment Procedure (Onboard the CCGS *Amundsen*)

1. Instruments programmed and mounted into respective frames / floats

2. Verify Mooring releases function properly
3. Assemble the mooring Top-down on the fore-deck as per mooring design
4. Mooring Equipment attachments confirmed / double checked
5. Toolbox meeting with Mooring and Ship's mooring crew to identify roles and safety considerations (Zodiac® deployed if ice pack present)
6. Launch Zodiac® (if required)
7. Date and Time are recorded for the start of mooring operations by an observing mooring team member, stationed on the bridge.
8. Lower the first instrument buoy with the 500Hp winch, released at surface by SeaCatch®.
9. Have the zodiac attach a tow-line to the bow horn / tack from the top instrument buoy
10. The mooring line is then tacked / secured and the zodiac is then instructed to maintain a taught-line (not tight), unless otherwise instructed by the lead mooring professional / chief officer.
11. Raise the next instrument off of the deck and extend the A-frame, undoing the mooring line tack before the instrument reaches the deck edge.
12. Descend the instrument and release the safety pin of the SeaCatch®, at deck level, then subsequently releasing the SeaCatch® and top float at the water surface. **Depending on wave conditions, timing of SeaCatch® release may need to be timed with a high in wave period.*
13. The SeaCatch® is then brought back to the deck level (A-frame brought back in at the same time) and attached to the next solid structure (i.e. cage), pearl link / d-ring (added to the top-side of next device to be lifted).
14. Pay-out the mooring line until there is 5-10m remaining (10m is advisable for rough seas). Then put the mooring line on-tack.
15. The next instrument is then raised by the 500hp winch wire as the mooring line in-tack is released
16. The same procedure of lowering the device to the water then putting the mooring line on tack, then attaching the SeaCatch® to the top-side of the next device follows until each device is in the water. Meanwhile, the zodiac continues to maintain a taught-line , so as to not allow for the deployed / in-water equipment to get entangled
17. The final release of the anchor is preceded by the zodiac releasing its tow-line of the top float (if zodiac is in the water) and the chief officer confirms the tagline release from the zodiac and confirmation that the vessel is at the desired depth / position.
18. The SeaCatch® on the Anchor chain shackle (located in the middle of the 2m anchor chain , just above the protective chain cylinder) was released (proceeding permission from the bridge) and the mooring free-falls into position at depth.
19. The Zodiac® and 4th team member (usually multibeam operator on *Amundsen*) on the bridge then marks the time and mooring / target location of the last seen vertical position of the top float on-descent (if zodiac is in the water).
20. The Zodiac® returns to the vessel and the A-frame and 500hp winch are stopped and secured (if zodiac is deployed).
21. The vessel then proceeds to 3 triangulation points around the target location (distance of mooring depth away from drop location) and verification of acoustic release communications through ranging / 'pinging' allow for the anchor position to be calculated. These data were then input into a MatLab® triangulation script to determine the triangulated position of the mooring and kept within the field deployment sheets (Figure 6.4).

22. Multibeam survey was performed to confirm the orientation and triangulated position of the mooring. Depending on the vessel's proximity to the mooring line, equipment and top-float depths might be visible if the vessel travels directly over-top the mooring. The multibeam images for each mooring deployment were kept within the field deployment workbook (EXCEL) and also archived at ArcticNet (Figure 6.5).
23. A post-deployment CTD cast / profile was taken, though pre-deployment cast is sufficient if the CTD-Rosette is programmed to take several water samples at the same time while profiling the water column. The CTD profile plots for each mooring were kept within the field deployment workbook (EXCEL) and also archived at ArcticNet (Figure 6.6).
24. The fore deck is cleaned of debris and remaining mooring equipment / cages are secured on the foredeck.

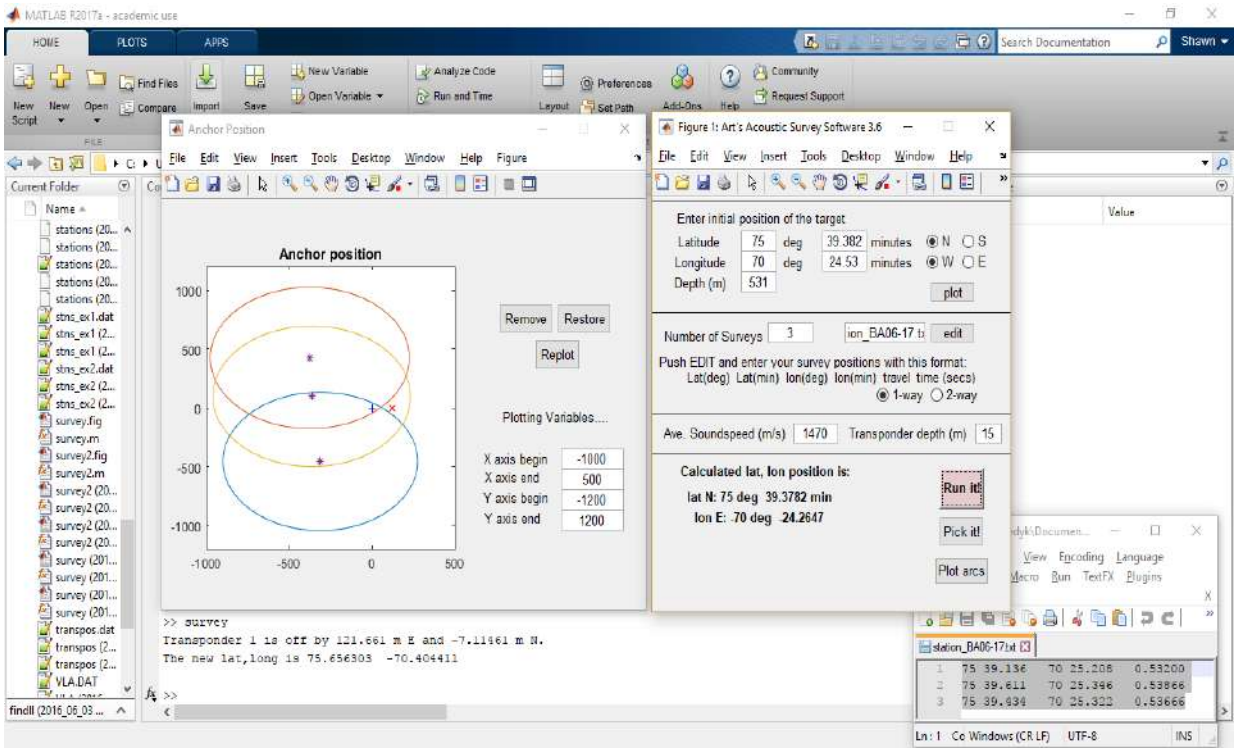

Figure 6-12 Triangulation Plot from BA06-17 using Art's Acoustic Survey Matlab Script

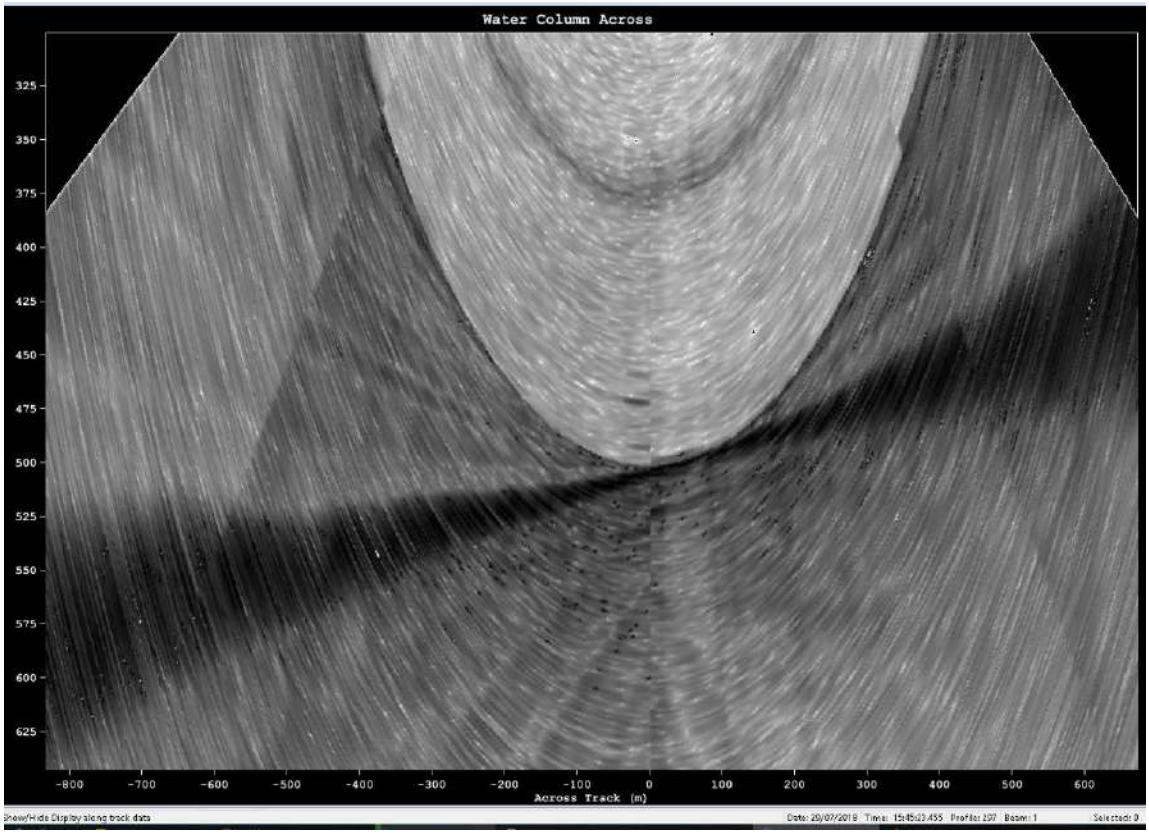

Figure 6-13 Multibeam imagery identifying orientation and instrument depths (Photo credit – Lukka 2018 – HiBioA-17 recovery)

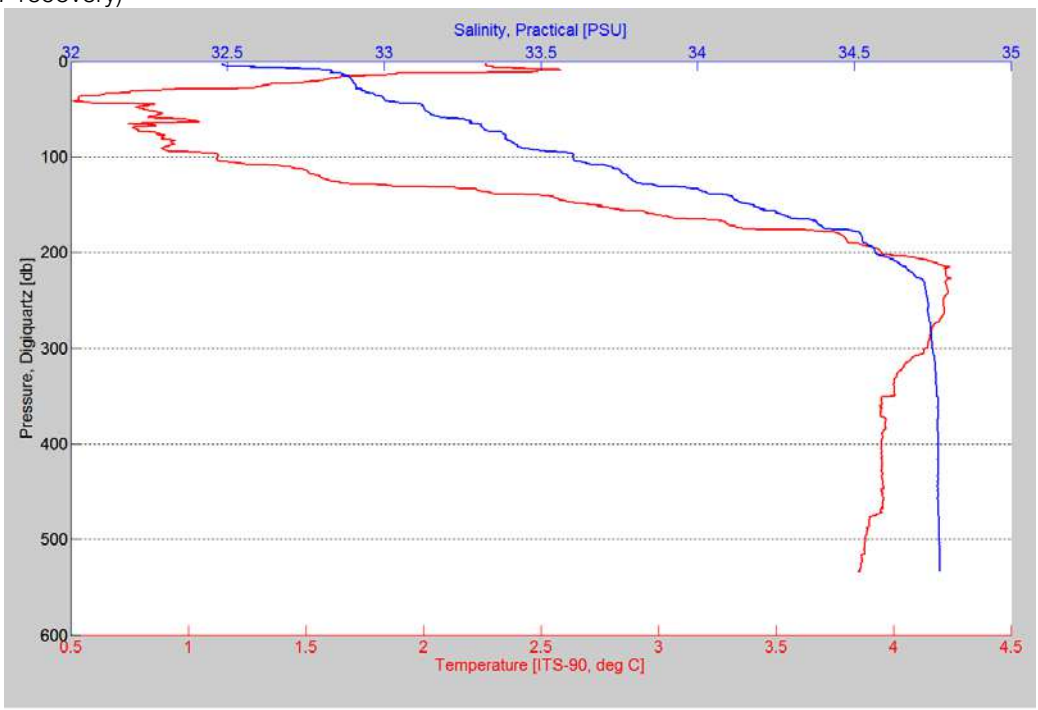

Figure 6-14 Rosette Temperature - Salinity Profile example plot (HiBioA-17)

6.2.4 *Mooring Operations – Annual Lessons Learned Summary*

Table 6-2 Summary table of Lessons Learned throughout the Amundsen 2018 mission

Problem	Solution	Operation
Stainless frame quality prevented current meter re-deployment	Good quality frames from Mooring Systems Inc. should be purchased	Deployment
Directional Aquadopp Profiler side-lobe interference	Use a omni-directional Aquadopp current profiler mounted inverted.	Data Quality
Stainless shackle corrosion	On-going issue with Arctic year-long moorings. Custom isolators for SS shackles or Dyneema Shackles could be used to remove corrosion possibilities.	Recovery
Galvanized shackle corrosion	Get certified galvanized new Crosby shackles directly from Crosby.	Recovery
Winch wire acoustic release connecting in rolling seas can cause the release pin to get jammed and blow a fuse during benthic lander deployments.	Pre-load the acoustic release with a shackle (1/2'' or 5/8'' Galv. Shackle works). Also, carry 1-2 spare fuses for the Benthos releases in the Red trays in the Mooring workshop.	Deployment
QM/LR Ext. Battery Case Bulkhead connecter rubber separation from oblique angle pulling on cold rubber	Use a heat gun when removing the connector from the bulkhead and check for rubber separation under pins before deployment / during maintenance	Deployment

Acknowledgements

I would like to acknowledge the teamwork and co-operation between the Coast Guard crew of the CCGS *Amundsen* and CCGS *Laurier* and the Mooring Team (Shawn Meredyk, Luc Michaud, Thomas Linkowski, Alexandre Forest, Greg Curtiss (Golder) and David Hurley (Golder)). Working together as a team and performing admirably under extreme weather conditions, the moorings were successfully deployed, recovered and re-deployed efficiently and safely as possible.

I would also like to acknowledge the teamwork and co-operation of Dr. Humfrey Melling (IOS) and the CCGS *Sir-Wilfred Laurier* for their hard work and cooperation with the ArcticNet / Amundsen Science / Golder Mooring Team.

7 CTD-Rosette, LADCP and UVP operations – Legs 0, 1, 2 and 3

Project Leader: Alexandre Forest[1] (alexandre.forest@as.ulaval.ca)
Cruise participants Leg 1: Pascal Guillot[2] and Camille Wilhelmy[1]
Cruise participants Leg 2a: Thomas Linkowski[1] and Solenne Caous[1]
Cruise participants Leg 2b: Claudie Marec[3] and Marc Picheral[4]
Cruise participants Leg 2c: Pascal Guillot[2] and Solenne Caous[1]
Cruise participants Leg 3: Thomas Linkowski[1] and Solenne Caous[1]
[1] *Amundsen Science, Université Laval, Québec, QC, Canada*
[2] *Institut des sciences de la mer, Université du Québec à Rimouski, Rimouski, QC, Canada*
[3] *Takuvik, Université Laval, Québec, QC, Canada*
[4] *Laboratoire d'Océanographie de Villefranche-sur-Mer, Villefranche, France*

7.1 Introduction

The objective of this shipboard fieldwork was to characterize the water column physical and chemical properties: temperature, salinity, fluorescence, CDOM, dissolved oxygen concentration, nitrate concentration, light penetration and turbidity. A SBE 911 CTD was used in conjunction with various other sensors mounted on a cylindrical frame known as a Rosette. A 300 kHz Lowered Acoustic Doppler Current Profiler (LADCP) was attached to the frame to provide vertical profiles of the velocities on station. The Rosette was also equipped with Niskin bottles, which were used to supply water samples for biologists and chemists.

7.2 Methodology

7.2.1 *CTD – Rosette*

The Rosette frame is equipped with twenty-four (24) 12-litre bottles and the sensors described in

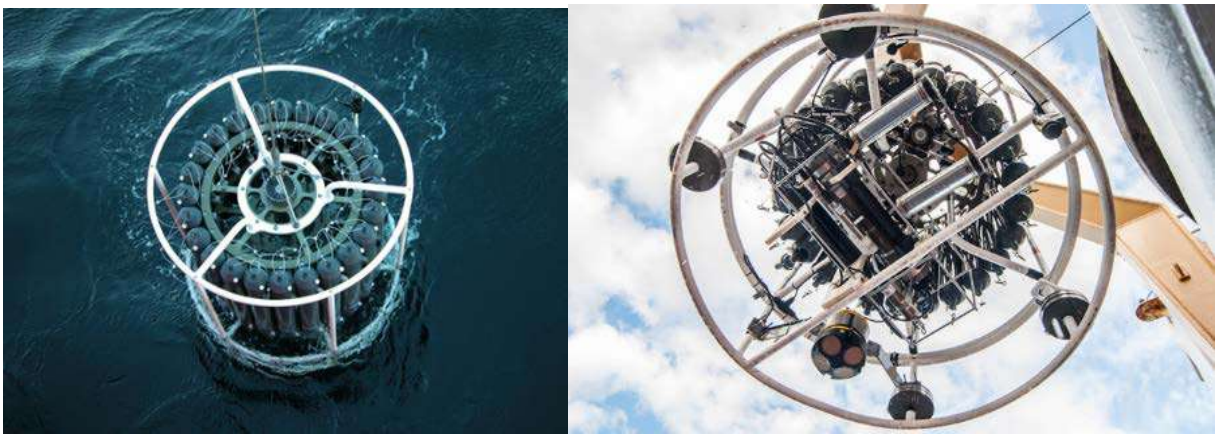

Figure 7-1 Top view of the SBE32 with 24x 12L Niskin bottles used on the *Amundsen* (left) and bottom view of the SBE32 showing the SBE9 CTD including additional sensors and the RDI LADCP (right). Photos : Jessy Barrette.

Table 7-1 Rosette Sensors

Instrument	Parameter	Properties	Serial Number	Calibration date
Sea-Bird SBE 911plus	CTP	Sampling rate : 24 Hz	09P24760-0679	
SBE 3plus	Temperature	Range: -5°C to + 35°C Accuracy: 0.001	03P4318 03P4204	25-Oct-2016 25-Oct-2016
ParoscientificDigiquartz®	Pressure	Accuracy: 0.015% of full range	0679	12-Nov-2016
SBE 4C	Conductivity	Range: 0 to 7 S/m Accuracy: 0.0003	042696 042876	26-Oct-2016 26-Oct-2016
SBE 43	Dissolved Oxygen	Range: 120% of saturation Accuracy: 2% of saturation	430240	28-Oct-2016
MBARI-ISUS Satlantic	Nitrates	Range: 0.5 to 200 µM Accuracy: ± 2 µM	132 (137)	08-May-2017 18-May-2016
QCP-2300 Biosherical	PAR	PAR Dynamic Range: $1.4x10^{-5}$ to 0.5 µE/(cm^2 sec)	7270	02-Fev-2017
QCR-2200 Biosherical	Surface PAR	PAR Spectral Response: Equal (better than ±10%) quantum response from 400 to 700nm	20147	02-Fev-2017
Seapoint	Fluorometer	Minimum Detectable Level 0.02 µg/l Gain Sens, V/(µg/l) Range/(µg/l), 10x 0.33 15	SCT-3119 Nr 1 (bottom) SCT-3120 Nr 2 (top)	1-Jan-2016 15-May-2017
WetLabs C-Star	Transmissometer	Path length: 25 cm Sensitivity: 1.25 mV	CST-671DR	08-Jun-2017
Teledyne PSA-916	Altimeter	Range: 50 m from bottom	1044	Feb 2014
WetLabs ECO	fluorometer (CDOM)	FL(RT)D Digital output resolution : 14 bit Analog output signal: 0-5V Range: 0.09-500ppb Ex/Em: 370/460nm	FLCDRTD-2344	02-Apr-2017
SBE 18	pH	Measurement range 0 – 14 pH Accuracy 0.1 pH Time response 1 second	180760	15-Aug-2017

Table 7-2 Sensors Specifications

Parameter	Sensor	Range	Accuracy	Resolution

	Compagny	Instrument Type			
Attached to the Rosette					
Data Logger	SeaBird	SBE-9plus [1]			
Temperature	SeaBird	SBE-03 [1]	-5°C à +35°C	0.001°C	0.0002°C
Conductivity	SeaBird	SBE-4C [1]	0-7 S/m (0-70mmho/cm)	0.0003 S/m (0.003mmho/cm)	0.00004 S/m (0.0004 mmho/cm)
Pressure	Paroscientific	410K-105	up to 10 500m (15 000psia)[2]	0.015% of full scale	0.001% of full scale
Dissolved oxygen	SeaBird	SBE-43 [3]	120% of surface saturation[4]	2% of saturation	unknown
Nitrates concentration	Satlantic	MBARI-ISUS 5T [6]	0.5 to 2000 µM	2 µM	0.5 µM
Light intensity (PAR)	Biospherical	QCP-2300			
sPAR	Biospherical	QCR-2200			
Fluorescence	Seapoint	Chlorophyll-fluorometer	0.02-150 g/l	unknown	30
pH	SeaBird	SBE 18	0-14 pH	± 0.1 pH	unkown
Transmissiometer	Wetlabs	C-Star	0-5 V	unknown	1.25 mV
Altimeter	Benthos	PSA-916 [7]	0 - 100 m	unknown	0.01 m
CDOM fluorescence	Wet Labs	FL(RT)D [7]	0.09-500ppb	unknown	14 bit

Notes: [1] Maximum depth of 6800m

[2] Depending on the configuration

[3] Maximum depth of 7,000m

[4] In all natural waters, fresh and marine

[5] Maximum depth of 1,200m

[6] Maximum depth of 1,000m

[7] Maximum depth of 6,000m

Problems Encountered with the CTD-Rosette and its Sensors

Leg 1

- The ISUS showed an important offset during the first casts of Leg 1. As the ISUS has reached it's end of life, it has been replace with the one from the moonpool Rosette. It will be important to think of a replacement for this instrument.
- Most of the bottles leaked during the first few casts. The elastic have been tightened and this issue disappeared.
- CDOM values got really low at some point. A re-calibration was necessary to obtain the proper values.
- Blue grease is leaking from the new winch cable causing an accumulation of dirt on the cable, on the ground and on the rosette. A washing device has been created to clean de cable as the rosette is lowered in the water column.

Leg 2

- LADCP processing got problematic. A bug in the code was the source of this issue. Once found, the LADCP processing was back on track!
- The CDOM failed to record values. Only noise was detected. After investigation, it's been decided to send the instrument to Wetlab so they can analyse what's wrong with it.
- The C-star calibration needed to be done again. Values over 100% were detected prior to the re-calibration.

Leg 3

- We lost the communication with the LADCP during one cast. It turned out the cable was in a bad state. Once chance, the LADCP communication was fine.

7.2.2 *Probes Calibration*

Salinity

Seabird CTD

Water samples were taken on several casts with 200 ml bottles. They were analyzed with a GuildLine, Autosal model 8400B. Its range goes from 0.005 to 42 PSU with an accuracy better than 0.002.

The analysis of the correlation between the CTD probe and the salinity samples will allow adjusting the profile values of salinity recorded with the SBE4C.

Seabird TSG.

Water samples were taken at different times during the transit from the surface thermosalinograph to measure salinity and fluorescence. The probe is located in the engine room. The samples were also analyzed with the GuildLine.

Oxygen

Oxygen sensor calibration was performed based on dissolved oxygen concentration measured in water samples using Winkler's method and a Mettler Toledo titration machine.

7.2.3 *Water Sampling*

Water was sampled with the rosette according to each team's requests. To identify each water sample, we used the term "rosette cast" to describe one CTD-rosette operation. A different cast number is associated with each cast. The cast number is incremented every time the rosette is lowered in the water. The cast number is a seven-digit number: xxyyzzz, with

xx : the last two digits of the current year;
yy : a sequential cruise number;
zzz : the sequential cast number.
For this cruise, the first cast number is: 1899001. To identify the twenty-four rosette bottles on this cast we simply append the bottle number: 1899001nn, where "nn" is the bottle number (01 to 24).

All the information concerning the Rosette casts is summarized in the CTD Logbook (one row per cast). The information includes the cast and event number and station id, date and time of sampling in UTC, latitude and longitude, bottom and cast depths, and minimalist comments concerning the casts (Appendix 3).

An Excel® Rosette Sheet is also created for every single cast. It includes the same information as the CTD Logbook plus a table of what was actually sampled and at what depth. Weather information and ice conditions at the sampling time is included in each Rosette. For every cast, data from three seconds after a bottle is closed to seven seconds later is averaged and recorded in the ascii 'bottle files' (files with a btl extension). The information includes the bottle number, time and date, trip pressure, temperature, salinity, light transmission, fluorescence, dissolved oxygen, irradiance and CDOM measurements.

All those files are available in the directory "Data\Rosette" on the 'Data' folder on the Amundsen server. There are six sub-directories in the rosette folder.

- \Rosette\log\: Rosette sheets and CTD logbooks.
- \Rosette\plots\: plots of every cast including salinity, temperature, oxygen, light transmission, nitrate, fluorescence and irradiance data.
- \Rosette\odv\: Ocean Data Viewer file that include ctd cast files.
- \Rosette\svp\: bin average files to help multibeam team to create a salinity velocity profile.
- \Rosette\avg\: bin average files of every cast.
- \Rosette\LADCP\: LADCP post-process data results.

7.2.4 *L*

Lowered Acoustic Doppler Current Profiler (LADCP)

On Legs 1, 2 and 3, a 300 kHz LADCP (RD-Instrument Workhorse®) was mounted on the rosette frame in upward and downward looking position. The LADCPs get their power through a battery installed on the rosette frame and the data is uploaded on the rosette acquisition computer connected to the instrument through a RS-232 interface after each cast. The LADCP are programmed in individual ping mode (one every second). The horizontal velocities are averaged over thirty-two, 8 m bins for a total (theoretical) range of 100 to 120 m. The settings are 57600 bauds, with no parity and one stop bit. Since the LADCP are lowered with the rosette, there will be several measurements for each depth interval. The processing is done in Matlab® according to Visbek (2002; J. Atmos. Ocean. Tech., 19, 794-807)

Figure 7-2 Lowered Acoustic Doppler Current Profiler (LADCP)

7.3 Preliminary Results

Data processing of the CTD-Rossette can take a while. The procced data will be made available on the polar data catalogue once ready. Sections below present exemples of raw data for each leg.

7.3.1 *Leg 1*

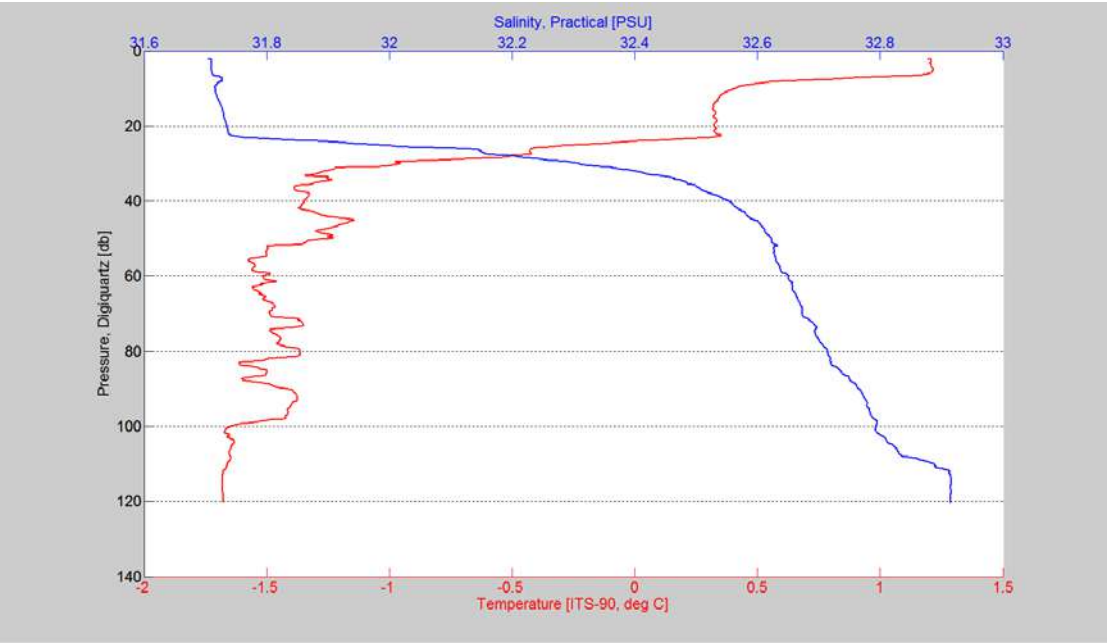

Figure 7-3 Temperature and salinity profiles. Cast 1801036

7.3.2 *Leg 2*

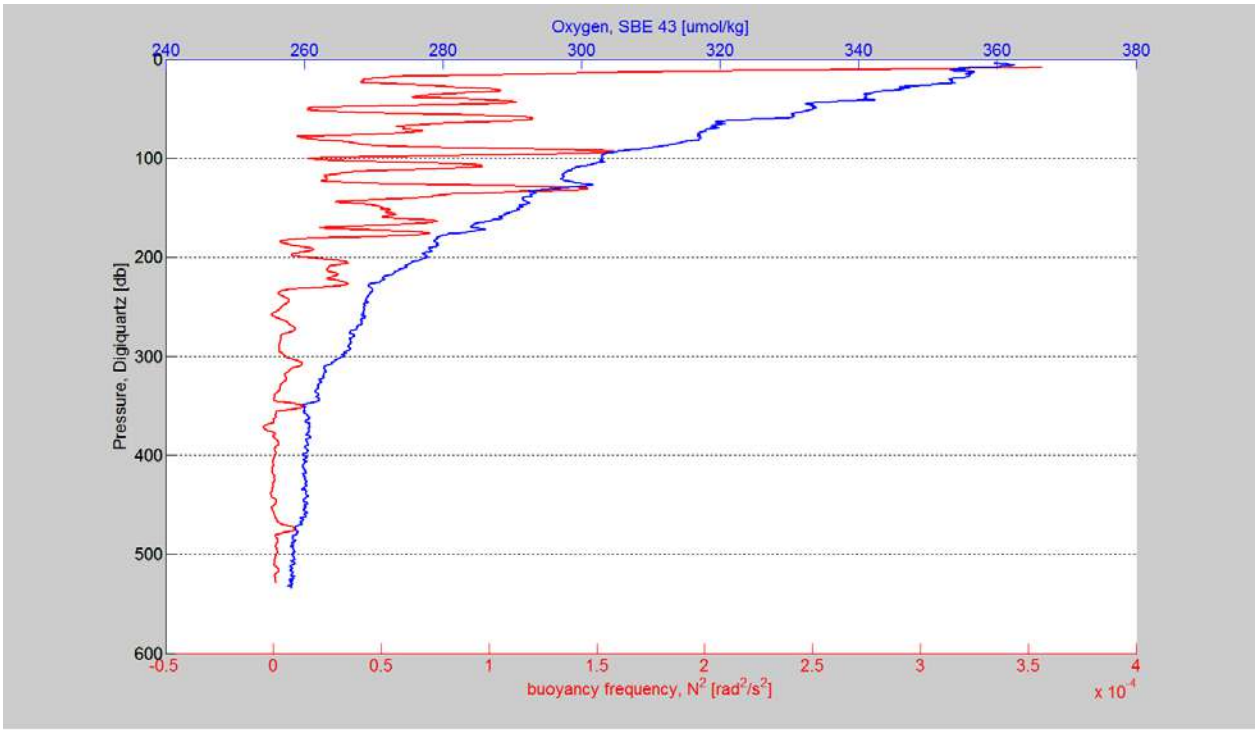

Figure 7-4 Buoyancy frequency and oxygen saturation profiles. Cast 1802026

7.3.3 *Leg 3*

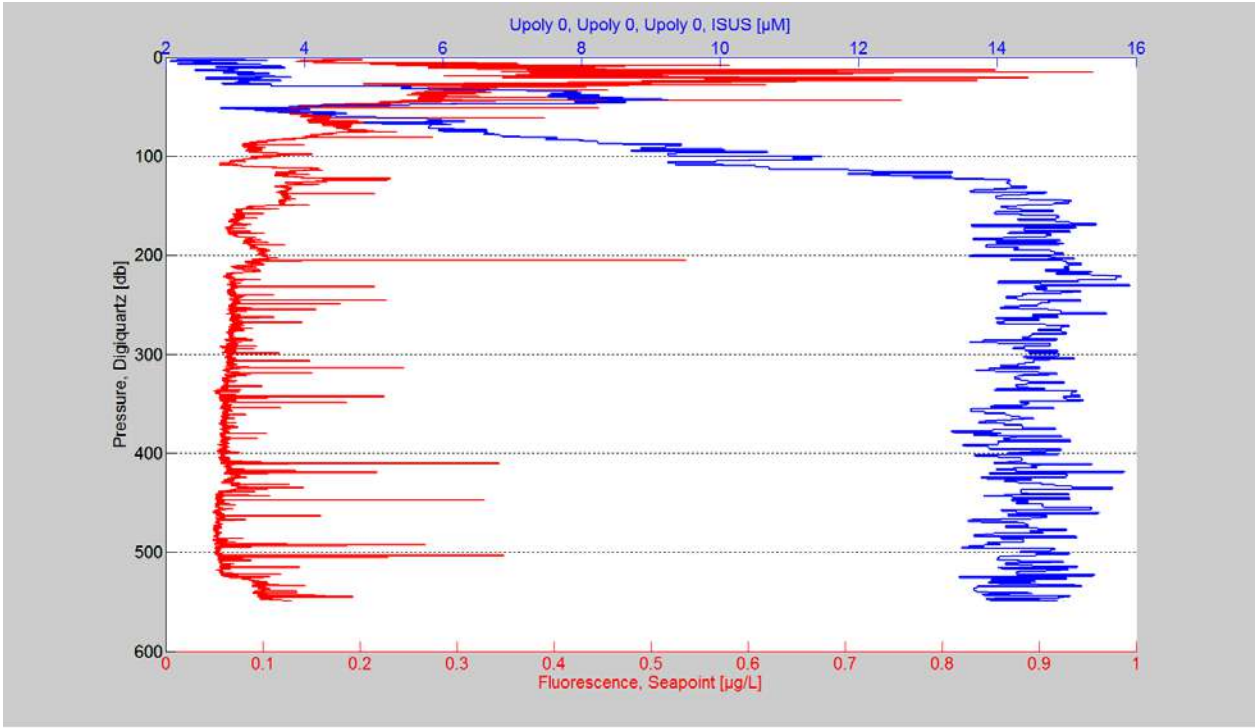

Figure 7-5 Fluorescence and nitrate profiles. Cast 1803011

8 Apparent and Inherent Optical Properties of Open and Ice-Covered Hudson Bay in Relation to Primary Production Dynamics and Distribution of Organic and Inorganic Matter, Tracing of Freshwater and River Plumes – Leg 1 and 2a

Project leaders: Jens Ehn[1] (jens.ehn@umanitoba.ca), C.J. Mundy[1] and Simon Bélanger[2]
Cruise participants – Leg 1: Atreya Basu[1], Lucas Barbedos de Freitas[2], Lisa Matthes[1], Laura Dalman[1], Rachel Hussher[2] and Julie Mayor[2]
Cruise participants – Leg 2a: Atreya Basu[1]
[1] *Centre for Earth Observation Science, University of Manitoba, Winnipeg, MB, Canada*
[2] *Département de biologie, chimie et géographie, Université du Québec à Rimouski, Rimouski, QC, Canada*

8.1 Introduction

The research goal of our team was to use optical measurements accompanied by water and ice sampling for biological and oceanographic parameters to gain information about spring primary production and the distribution and concentration freshwater, sediments and organic matter in the Hudson Bay System (HBS). The system is influenced by a large freshwater input from rivers and sea ice melt at this time of the year. Three PhD projects dealing with different aspects of the main objectives were involved in this cruise:

Atreya Basu

Being a member of the "BaySys" Team 1- Marine and climate system and as a PhD student it is my mandate to map the freshwater distribution in the Hudson Bay during the spring freshet season. Thus, this study will focus on the response of surface freshwater distribution during the open water season to climate variability and hydroelectric regulation. My approach is to use satellite-derived optical proxies and field-based observations, carried out in the fall and spring season, for the development of a Hudson Bay specific ocean color remote sensing algorithms which characterizes the freshwater distribution. One of the main challenges will be the partitioning of freshwater origins such as sea ice melt and riverine components. Hudson Bay is fully ice-covered over several months and has a large number of rivers draining into the bay. The coastal waters will be one of the prime geographical focus areas of my research with an emphasis on the Nelson-Hayes river estuary. To achieve the following objectives, in situ field data collection is a mandatory requirement and for which I am onboard the CCGS *Amundsen*.

The collected dataset is going to supply crucial information to fill the following objectives:

1. Studying the optical interdependency among CDOM and particulates in the Hudson Bay: A precursor to the freshwater tracing algorithm
2. Studying the distribution of runoff, sea ice melt, sea ice during spring freshet in the Hudson Bay using salinity- δ^{18}O-CDOM measurements
3. Tracing river plumes in the coastal Hudson Bay (Canada) using satellite remote sensing: Influence of Non-Algal Particles on Remote sensing reflectance and aCDOM retrieval

4. Optical delineation the Nelson-Hayes River plume extent (Hudson Bay, Canada) using a satellite remote sensing approach (2012-2018)

Lucas Barbedos De Freitas

The dataset acquired during the BaySys 2018 Expedition will improve the satellite Net Primary Production (NPP) model developed over the last year at UQAR-Takuvik. The model is based on in situ samples of biological parameters as well as in-water and above water radiometry measurements [Babin et al., 2015; Lee et al., 2015]. Hudson Bay is characterized as a domain of optically complex waters with relatively high spatial-temporal variability in the optical properties [Xi et al., 2013, 2014, 2015], therefore, measurements have to be carried out on a high spatial resolution. The collected dataset is going to supply crucial information to fill the following objectives:

1. Regionalize the remote sensing depth and wavelength resolved net phytoplankton primary production model [Platt et al., 1980] through in situ radiometry, Apparent Optical Properties (AOP), satellite match-up and water column structure in HBS
2. Perform a sensitivity study of the NPP algorithm to bio-optical parameters ([Chl a], photosynthetic parameters, diffuse attenuation coefficient for downwelling irradiance (Kd(λ)) and oceanographic processes to estimate the absolute model uncertainty
3. Assess the uncertainty of the satellite NPP model when there are evidences that the bloom occurred under ice
4. Evaluate the capability of the satellite NPP model to access under-ice production

Lisa Matthes

An indication for significant phytoplankton growth in late spring is the changing sea ice conditions of the Hudson Bay system during the last decades such as a significant decline of -15.1 % /decade in sea ice concentration in the western and north-western parts of the Bay [Hochheim et al. 2010]. Up to now, primary production measurements were mainly performed in open water between June and September in Hudson Bay [Legendre and Simard 1979; Grainger 1982; Ferland et al. 2011], neglecting a potential under-ice and/or ice algae spring bloom and resulting in low annual production estimates. Additionally, little is known about the photophysiological adaptation of present algae communities to these quickly changing environmental conditions in late spring. My project aims to investigate the following objects during the summer cruise:

1. Investigate the role of spectral light availability on the timing and location of spring primary production with a retreating sea-ice cover in Hudson Bay
2. Quantify the seasonal variability in spectral light attenuation in the upper water column associated with biological properties of primary producers, dissolved organic matter and non-algal particles
3. Describe the variability in primary production in the Nelson estuary along a salinity gradient during spring melt

8.2 Methodology

Sampling was conducted in the open water of Hudson Bay, on ice and via helicopter at several rivers (Figure 9.1). Water samples for the analysis of oceanographic, optical and biological parameters were collected from the rosette at six optical depths as well as at deeper depths according to stratification patterns of the water column. Simultaneously, optical instruments were deployed from the foredeck to measure the reflection of light at the water surface, the extinction of light in the water column and the concentration and distribution of particulate and dissolved matter impacting the propagation of light through absorption and scattering processes. Table 9.1 provides an overview about the sampled parameters at each station during Leg 1.

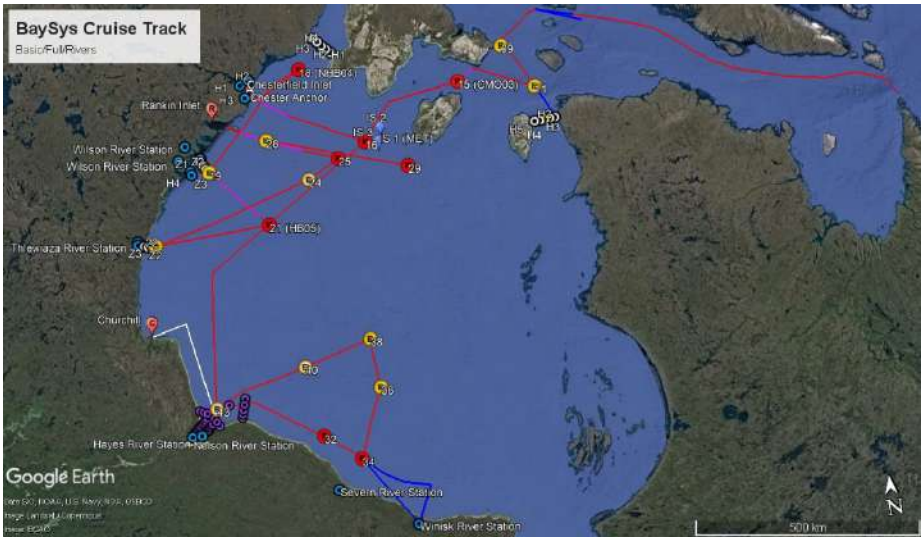

Figure 8-1 Water sampling and the deployment of optical instruments were performed at full and basic stations (B,F). Ice work including under-ice light measurements and the sampling of ice cores was carried out at several stations.

8.2.1 *Optical operations*

From the foredeck, measurements of surface reflection were conducted with the Hyperspectral Surface Acquisition System (HyperSAS, Satlantic, USA) following the methodology of Mobley [1999]. In-water radiometric profiles of light extinction were recorded by the submersible spectroradiometer Compact Optic Profile System (C-OPS, Biospherical Instruments Inc., USA) using similar methodology of Hooker et al., (2013). To complete dataset interpretation, Secchi disk depth was measured before the deployment of the C-OPS. Additionally, a photographic report was performed continually during each station and ship transects to monitor the sea-ice, atmospheric and sea state.

Total atmospheric ozone, water vapor and aerosol measurements are conducted using the handheld ozone monitor and Sun photometer Microtops II [Morys et al., 2001]. This dataset will help to improve the atmospheric correction related to ocean color satellite observations.

Measurements of the inherent optical properties such as absorption and scattering by particles (phytoplankton, sediment, detritus) and colored dissolved organic matter (CDOM) were conducted via instruments (AC-S, BB9, BB3, CTD-probe, fluorometer) attached to a metal frame. The frame was lowered with the help of the A-frame at the foredeck to the water surface and several profiles from the water surface to the bottom were recorded. The deployment of the Laser In-Situ Scattero-/Transmissometer (LISST 100x, Sequoia Scientific Inc., USA) followed to measure particle size distribution and concentration along the same profile.

To determine the optical depths for water sampling via the rosette, a Profiling Natural Fluorometer (PNF-300, Biospherical Instruments Inc., USA) was deployed from the foredeck. The ship was positioned towards the sun, so that the recorded light profile was not contaminated by the ship shade. Afterwards, the diffuse attenuation coefficient of downwelling irradiance was calculated to determine 6 optical depths: 100 %, 30 %, 15 %, 5 %, 1 %, 0.2 %.

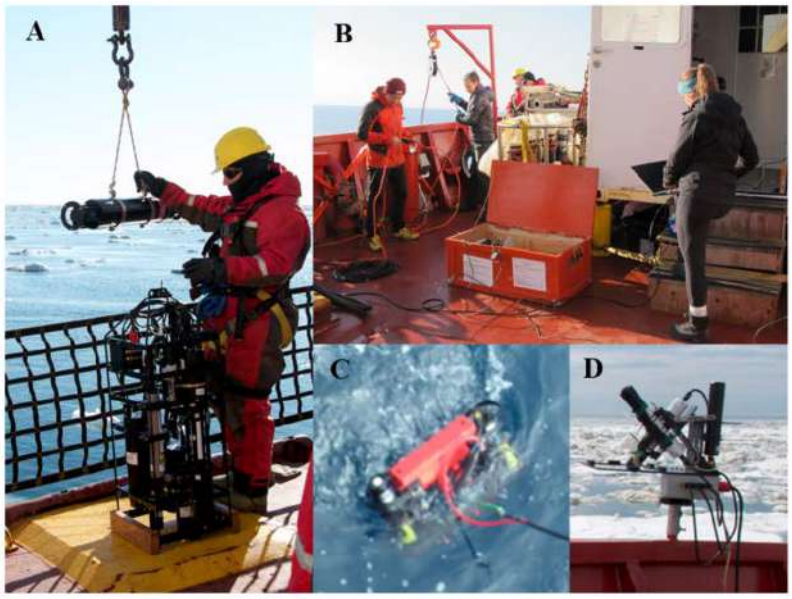

Figure 8-2 : Optical instruments A) LISST, IOP-frame, B) PNF, C) C-OPS, D) HyperSAS (Photo Credit: Lucette Barber, Lisa Matthes, Lucas Barbedos de Freitas).

8.2.2 *Water sampling*

<u>^{14}C incubations</u>

Measurements to determine primary production in function of a light gradient were performed at 22 different locations during the cruise. Production vs. Irradiance (PE) curves were measured by incubating sea water, melt pond water and melted scrapes of the bottom ice cores inoculated with ^{14}C. The incubations were conducted according to the radioactive safety guidelines in the Radvan after the protocol of Takuvik (Marcel Babin, Université Laval). The incubator is a custom-made instrument adapted after the one presented in Babin et al. 1994 (Figure 9.3).

Figure 8-3 General set-up for the PE incubations in the Radvan. From right to left: inoculation space, incubator, filtration ramp, clean work space (Photo Credit: Rachel Hussherr).

Six or seven incubations were carried out at each station: either 6 optical depths (determined by PAR measurements from PNF 300) in the water column if the station was in open water, or 4 optical depths + ice bottom scrapes + melt pond/ interface water if the station was a mix of open water and sea ice floes. The seawater from each sampled depth was incubated in an individual incubation chamber for 3 to 4 hours depending of the in situ production in the water column. After filtration, samples were placed in a Beckman Coulter LS 6500 scintillation counter to count the ^{14}C uptake of algae cells. Afterwards, PE curves (Counts per minute in function of irradiance) were made for every water sample at each station.

Filtrations

Water samples, taken with the rosette from several water depths, were filtered for various parameters (Table 7.1). Thereby, sampling depths (optical depths, discrete depth levels based on stratification) were in line with the water sampling of other teams to gain a full picture of the biological, chemical and physical processes in the water column. Filtrations took place in the aft filtration lab under green light to minimize photodamage of the studied organic matter.

Table 9-1 Water sampling parameters collected during Leg 1.

Sampling depth	Parameter	Description
Optical depths, Ice samples	Chl *a*	Chlorophyll *a*
Optical depths, Ice samples	HPLC	High-performance liquid chromatography for pigment analysis
Optical depths, Ice samples, Discrete depths	POC/N	Particulate organic carbon and nitrogen
Optical depths, Ice samples, Discrete depths	a_p	Particulate absorption
Ice samples	Taxonomy	Species identification
Discrete depths	TSS	Total suspended sediment
Discrete depths	CDOM/FDOM	Colored dissolved organic matter
Discrete depths	Salinity	Salinity
Discrete depths	$\delta^{18}O$	Oxygen isotopes

Chorophyll a was analysed on board with a Fluorometer (Turner 10AU, Turner Designs, USA) following the method described in Parsons et al. [1984]. The filters for the analysis of the remaining parameters were stored in the fridge (4°C) or freezer (-80°C) to be transported back to the lab with the crew change. Additionally, water samples were collected for $\delta^{18}O$ and salinity measurements at discrete depth levels. Salinity samples were analysed using the onboard salinometer.

8.2.3 *Ice sampling*

To complete data collection for the investigation of spring primary production in Hudson Bay, samples of algae inhabiting the ice bottom were taken at each ice station. The last 5 cm of three ice cores as well as scrapes from the bottom of another three cores were collected to be filtered onboard for the biological parameters listed in table 2 as well as ^{14}C incubations (Fig. 4B). Additionally, water from the ice interface and melt ponds were collected via pump for the same objective. However, before ice cores for ice algae biomass were sampled, optical measurements were carried out in the undisturbed area to determine light availability for primary production at the ice bottom. Spectral albedo of different sea ice surface properties was measured prior to the under-ice light sampling with one hyperspectral radiometer (1 planar RAMSES-ACC, TriOS GmbH, Germany, Fig. 4A). Transmitted irradiance beneath the sea ice cover was recorded via a custom-built double-hinged aluminum pole (L-arm) and 3 hyperspectral radiometers (1 planar RAMSES-ACC, 2 scalar RAMSES-ASC, TriOS GmbH, Germany). Finally, ice thickness, freeboard, melt pond depth and snow height were measured at the ice core sampling site.

Figure 8-4 Measurement of surface albedo (A) and ice core sampling (B)

Table 9-2 Sampled parameters at each station type (Nutrient, Basic, Ice, Transect, Helicopter, River, Estuary).

Date	Station	Station type	Bottom depth [m]	Optical dep	^{14}C	Chl a	HPLC	POC/N	a_p	Taxo-nomy	TSS	CDOM/ FDOM	Sal	^{18}O	Sediment core
31-May	N01	Nutrient	386									x			
31-May	N02	Nutrient	566			x	x	x	x			x			
31-May	Brash	Random				x		x	x						
31-May	N03	Nutrient	419			x						x			
01-Jun	B04	Nutrient	283			x	x	x	x			x			
02-Jun	FB05	Nutrient	245			x	x	x	x		x	x			
02-Jun	FB07	Nutrient	274			x		x	x		x	x	x	x	
02-Jun	FB05-H	Helicopter										x	x	x	x
03-Jun	FB09	Basic	104	x	x	x	x	x	x		x	x			
03-Jun	B10	Nutrient	199			x			x			x	x	x	
04-Jun	B11	Basic	321	x	x	x	x	x	x		x	x			
04-Jun	B11-Ice	Ice floe										x	x	x	x
04-Jun	H3	Helicopter										x	x	x	
05-Jun	B12	Nutrient	83			x			x			x	x	x	
05-Jun	B13	Nutrient	144			x			x			x	x	x	
05-Jun	B15	Basic	189	x	x	x	x	x	x		x	x			
06-Jun	B16	Ice station	132	x	x	x	x	x	x	x	x	x			x
07-Jun	B17	Nutrient	90			x	x	x	x		x				
08-Jun	B18	Ice station	114	x	x	x	x	x	x	x	x				x
09-Jun	B19	Basic	86		x	x	x	x	x		x	x			
09-Jun	B19-Wilson	River				x		x				x	x	x	
		Estuary													
09-Jun	B19-Ferguson	River				x		x				x	x	x	
		Estuary													
09-Jun	B19-Zodiak	Transect										x	x	x	
09-Jun	B20	Nutrient	109			x	x	x	x			x	x	x	
10-Jun	B21	Basic/Ice	147	x	x	x	x	x	x	x	x	x	x	x	
11-Jun	B22	Basic	65	x	x	x	x	x	x		x	x	x	x	
11-Jun	B22-Thanne	River				x		x	x			x			

11-Jun	B22-Thlewiaza	River				x		x	x			x			
11-Jun	B19-Zodiak	Transect										x	x	x	
11-Jun	B23	Nutrient	110			x	x	x	x			x	x	x	
12-Jun	B24	Basic/Ice	185	x	x	x	x	x	x	x	x	x	x	x	
13-Jun	B25	Basic/Ice	149	x	x	x	x	x	x	x	x	x	x	x	
14-Jun	B26	Nutrient	129									x	x	x	
15-Jun	B28	Nutrient/Basic	160			x	x	x	x			x			
16-Jun	B29	Basic (Chem)	175	x		x		x	x		x	x			
18-Jun	B31 (AN02)	Nutrient	46			x		x	x		x	x	x	x	
18-Jun	Nelson	River				x		x	x		x	x			
18-Jun	Hayes	River				x		x	x		x	x			
19-Jun	B32	Basic	31	x	x	x	x	x	x		x	x			x
19-Jun	Severn	River				x		x	x		x	x			
19-Jun	B32	Ice										x	x	x	
20-Jun	B33	Nutrient/Ice (Bucket)				x		x	x	x	x	x	x	x	
20-Jun	Winisk	River				x		x	x		x	x	x	x	
20-Jun	B33-H(1-3)	Ice							x			x	x	x	
20-Jun	B34	Basic/Ice	45	x	x	x	x	x	x		x	x	x	x	
21-Jun	B34b	Ice		x		x	x	x	x	x		x	x	x	x
21-Jun	B34b-Z	Water				x		x	x		x	x	x	x	
21-Jun	B35	Nutrient	60			x		x	x		x	x			
22-Jun	B36	Basic/Ice	126	x	x	x	x	x	x	x	x	x	x	x	x
22-Jun	B36-HA	Helicopter				x						x			
22-Jun	B36-HB	Helicopter				x						x			
22-Jun	B36-HC	Helicopter				x						x			
22-Jun	B36-HD	Helicopter				x						x			
23-Jun	B38	Basic/Ice	179	x	x	x	x	x	x		x	x			x
24-Jun	B39	Nutrients	180									x	x	x	
24-Jun	B40	Basic/Ice	90	x	x	x	x	x	x		x	x			
27-Jun	B15-2	Nutrient	190			x	x	x	x			x	x	x	
27-Jun	L1	TSG				x	x	x	x						
27-Jun	L2	TSG				x	x	x	x						
27-Jun	L3	TSG				x	x	x	x						

28-Jun	B44	Basic	104	x	x	x	x	x	x		x	x	x	x	
29-Jun	Nelson-A	River	~5	x	x	x	x	x	x		x		x	x	
29-Jun	N-B	River	~5	x	x	x	x	x	x		x		x	x	
29-Jun	South-Transect	Estuary				x	x	x	x		x				
30-Jun	B45-R	Water			x	x	x	x	x		x		x	x	
30-Jun	N-C	River		x	x	x	x	x	x		x		x	x	
30-Jun	N-D	River		x	x	x	x	x	x		x		x	x	
01-Jul	B46-R	Water		x	x	x	x	x	x		x		x	x	
01-Jul	West-Transect	Estuary	15										x	x	

8.3 Preliminary Results

8.3.1 *Location of the highest chlorophyll* a *concentration in the water column*

The surface chlorophyll maximum (SCM) is shallower in low productive areas (close to the coast, ice edge and eastern entrance to Hudson Bay) compared to the very productive area in the center of the open water in the north-west of the bay (Figure 9.5). In this area, nutrients must have been completely depleted in the surface water column, so that a high phytoplankton abundance is only visible on top of the pycnocline through which nutrients diffuse from the richer bottom water layer. The southern part also showed a shallow SCM and a low phytoplankton concentration which could be related to the high ice coverage and an existing light limitation.

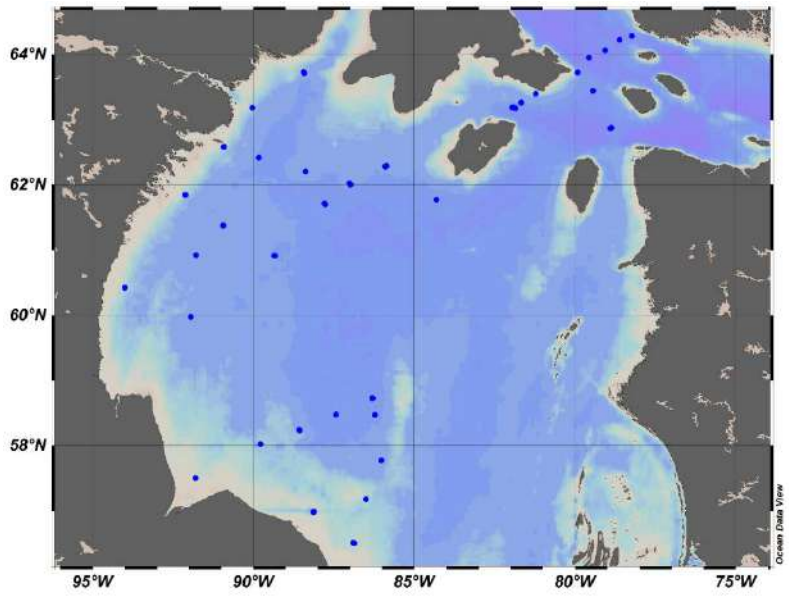

Figure 8-5 Depth of the surface chlorophyll maximum

8.3.2 *Chlorophyll concentration in the water column and ice bottom*

The concentration of chlorophyll a as a proxy for phytoplankton and ice algae abundance was measured at 6 optical depths in open and ice-covered water column, at the ice bottom and upstream of several rivers (Figure 7.6). Chlorophyll a concentration was higher at the SCM compared to the surface water layer. At the ice bottom, chlorophyll a concentration was much higher than expected. This is probably related to the large observed abundance of filamentous algae (genus Melosira) hanging down from the ice bottom in northern Hudson Bay. In southern Hudson Bay, a lower ice algae abundance was observed which could be related to the late sampling time (bloom terminated) and/or a higher freshwater concentration in the surface water layer. Chlorophyll a concentration of sampled rivers was lower at the north-west coast compared to the south coast. The highest concentration was measured in the Hayes river.

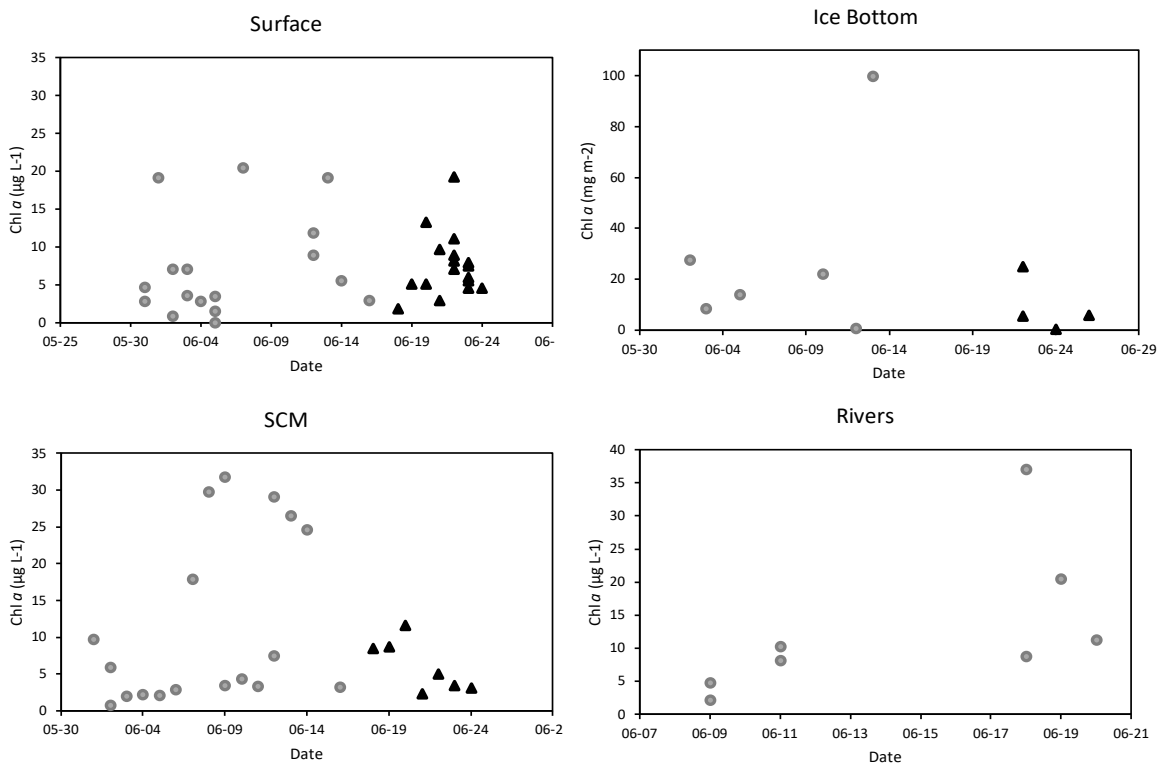

Figure 8-6 Chlorophyll a concentration sampled at the water surface in north-west Hudson Bay (grey) and south Hudson Bay (black), at the depth of the surface chlorophyll maximum (SCM), the ice bottom and upstream of rivers at the west and south coast of Hudson Bay.

8.3.3 *Additional Observations in the Nelson-Hayes Estuary*

Ship- and ice-based observations described above were supplemented using the ship's barge and Zodiac to sample across salinity gradients in the Nelson-Hayes estuary (Figure 7.7). Stations NA, NB (barge) and S1–S3 (Zodiac) were visited on 29 June; NC, NC (Zodiac) and BN3–BN7 (barge) and were visited on 30 June. W1–W3 were sampled on 1 July by rosette from the Amundsen. Stations NA and BN3 were in fresh water. At stations S1-S3, water was collected for Team Optics/Biology by the carbon and mercury teams.

Surface water samples collected at each station were filtered for TSS, ap, chlorophyll *a* and CDOM. The frame with attached inherent optical properties instruments (Wetlabs AC-S, BB9, BB3, CTD-probe, fluorometer) and the LISST instrument were deployed at stations NA and NB only (Atreya Basu). The Compact Optic Profile System was used to record radiometric profiles of light extinction at stations NA, NB and BN3–BN7 (Lucas Barbedos De Freitas). An Idronaut CTD was deployed at all Zodiac stations to record profiles of conductivity, temperature and optical backscatter. A Seabird 19+ CTD was deployed at barge stations to record conductivity, temperature, oxygen, chlorophyll fluorescence, CDOM fluorescence, beam transmission, and photosynthetically-active radiation through the water column. (The Seabird 19+ was also deployed from the Zodiac and/or from the ice at stations 32, 33, 34, 36, 38 and 40 in southern

and south-central Hudson Bay to record profiles away from upper water column disturbance by the ship's thrusters.)

Figure 8-7 Stations sampled by barge or Zodiac in the Nelson-Hayes estuary. The map on the right shows station locations in the area bounded by the box in the map on the left. Waypoints were recorded at the beginning and end of the period of observations and sampling at stations BN3-BN7. Similar drift at other stations in the estuary was not recorded.

8.4 Reference

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9 Freshwater Influence on Microbial Communities of the Hudson Bay System – Legs 1 and 2a

Project leader: Connie Lovejoy[1] (Connie.Lovejoy@bio.ulaval.ca)
Cruise participant – Legs 1 and 2a: Loïc Jacquemot [1]
[1] *Département de Biologie, Université Laval, Québec, QC, Canada*

9.1 Introduction

Freshwater is a major component of Hudson Bay System and influence physycial, biogeochemical and biological processes within the bay. As part as the Baysys team 3, my project aims to understand the influence of freshwater marine coupling on the microbial communities (protists, bacteria and archaea). My objectives are to identify key environmental factors (salinity, nutrients, temperature, pH) influencing the diversity, distribution and interactions within microbial assemblages at different scales, from the entire Hudson Bay System to local coastal regions of the bay. We will particularly focus on salinity gradient observed in surface at the ice edge and between river and coastal ocean in estuarine systems. In estuaries, combining effects of upstream and downstream processes are known to structure microbial plankton communities and to induce a clear taxonomic transition from river to ocean (Harvey et al., 1997), as they regulate the balance between advection of organisms from adjacent ecosystems (here river and coastal ocean) and selection by local-environmental conditions, predation or competition (Crump et al., 2004; Niño-García et al., 2016; Ruiz-González et al., 2015 add ref??). Recent molecular techniques such as $^{16}S/^{18}S$ amplicons sequencing and shotgun metagenomic will allow us to gain further into the structure of plankton communities and the potential genetic adaptations to salinity gradients. We hypothesize that microbial communities distribution in the Hudson Bay will be drive by freshwater circulation in surface. Some species will present genetic adaptations to these freshwater gradients.

9.2 Methodology

156 water samples were collected during Leg 1 of the mission onboard the CCGS *Amundsen* (Figure 10.1) and 19 water samples were collected during Leg 2a (Figure 10.2). We collected oceanic vertical profiles at 4 depth (suface, SCM, 70m and bottom) with the rosette and surface river water using the zodiac and the helicopter. We also use the zodiac to collect water at the ice edge or under the ice using a pump.Water for environmental DNA was collected into clean acid rinsed carboys of 10L. We immediately filtered 6 litres of water through a 50 um nylon mesh, a 47-mm diameter 3-um polycarbonacte filter and finally through a 0.2 um Sterivex unit (Millipore Canada Ltd, Mississauga, ON, Canada). 3-µm filter were folded and placed in 15 ml tubes with RNA-later buffer (ref). RNA-later buffer was added to the Sterivex units and the samples were stored at -80°C until nucleic acid extraction as in Potvin and Lovejoy (2009). Additional water was used to fix cells for flow cytometry, DAPI visualization on inverted microscope and FISH analysis. All samples were stored at -80°C.

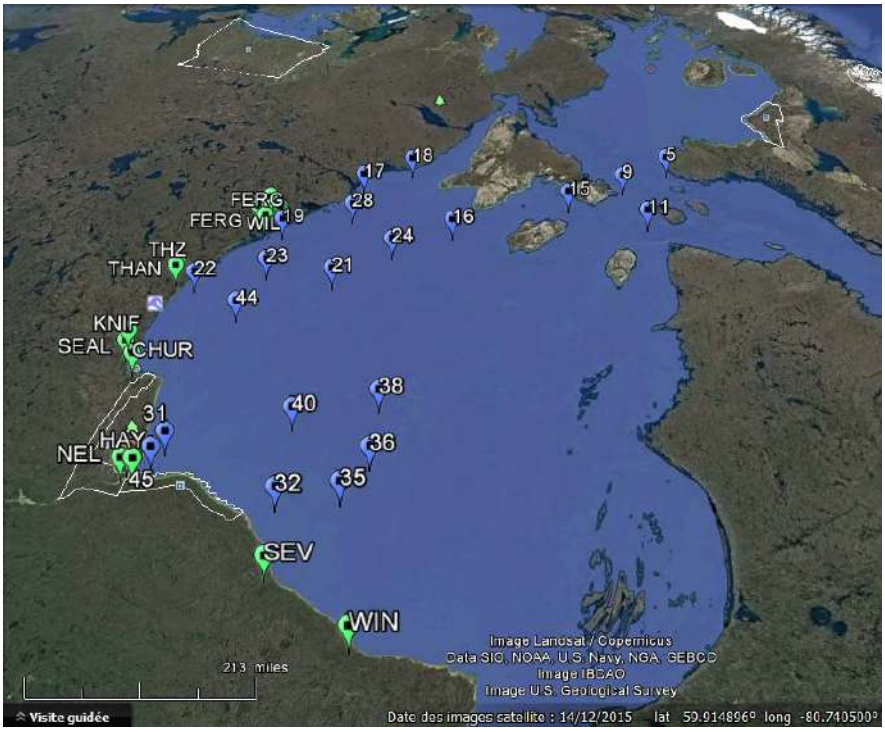

Figure 9-1 Locations of samples obtained during the Baysys mission (Leg 1). Blue dots were collected with the rosette and green dot were collected in river by helicopter.

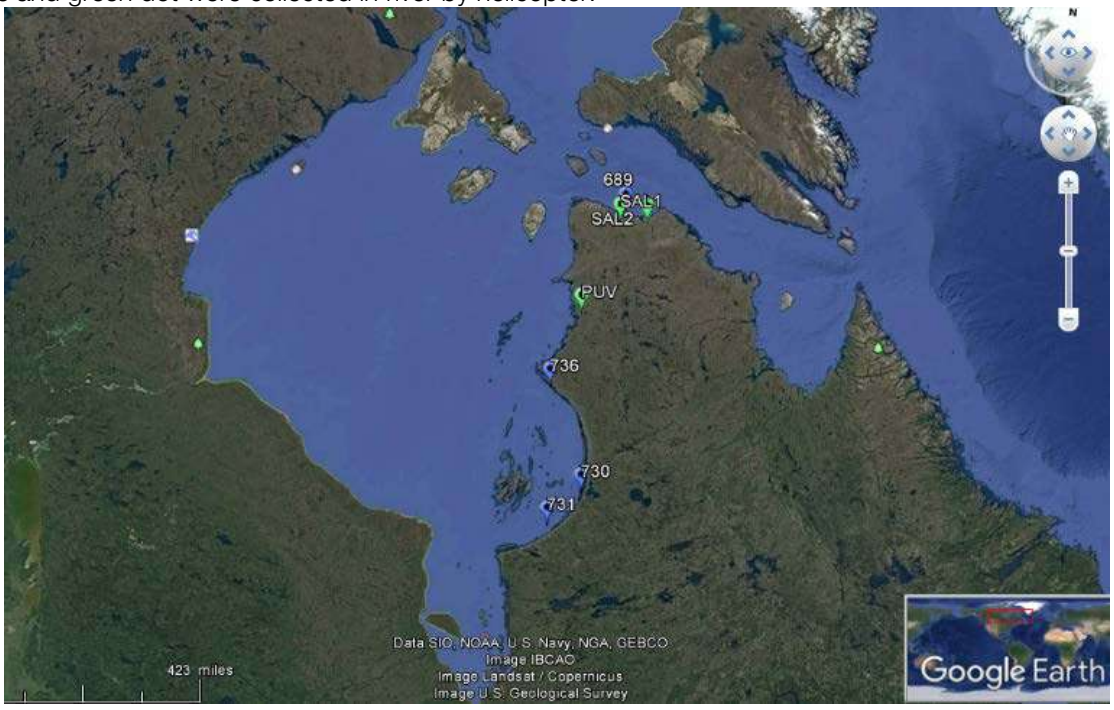

Figure 9-2 Locations of samples obtained during the Baysys mission (Leg 2a). Blue dots were collected with the rosette and green dot were collected in river by helicopter.

10 Zooplankton and Fish Ecology/Acoustics– Legs 1, 2 and 3

Project leaders: Louis Fortier[1] (louis.fortier@bio.ulaval.ca)
Cruise participants Leg 1: Cyril Aubry[1], Sarah Schembri[1] and Tommy Pontbriand[1]
Cruise participants Leg 2a: Thibaud Dezutter[1] and Sarah Schembri[1]
Cruise participants Leg 2b: Thibaud Dezutter[1]
Cruise participants Leg 2c: Thibaud Dezutter[1]
Cruise participants Leg 3: Gérald Darnis[1], Caroline Guilmette[1], Gabrielle Nadai[1] and Kirstie Jones-Williams[2]
[1] *Québec-Océan, Université Laval, Québec, QC, Canada*
[2] *British Antarctic Survey, Madingley Road, Cambridge, United Kingdom*

10.1 Introduction

The main objective of our team during 2018 expedition was the monitoring of zooplankton and fish key parameters (abundance, diversity, biomass and distribution) using various sampling devices and the EK60 echosounder. This leg included the last of 4 years of fieldwork within the framework of the Kitikmeot Marine Ecosystems Study in the Queen Maud Gulf area of the Kitikmeot region. Additional work was carried out as part of a new collaboration with a PI at the British Antarctic Survey (BAS) to investigate potential anthropogenic stressors on the zooplankton in this region, specifically ocean acidification and subsequent carbonate undersaturation, and to collect microplastics during transit between stations.

The specific objectives of Leg 1 were to;

- Compare zooplankton and fish species assemblages in different areas of the Hudson Bay system: comparison of coastal species assemblages with off-shore ones; comparison between the West, South and East coasts of the Hudson Bay.
- Find out which fish species develop in estuaries and along the ice-edge during the spring-melt season.
- Capture adult fish in Hudson Bay for the first time.

The specific objectives of Leg 2a were to;

- Complete the sampling for the BaySys project by sampling the East part of Hudson Bay and the Hudson Strait in order to compare the zooplankton and fish species assemblages in different areas of the Hudson Bay system.
- Sample zooplankton for BriGTH project for taxonomy and lipid analyses (Jean-Éric Tremblay). Because of heavy ice conditions, we were able to sample only 3 stations with the icebreaker and 2 stations with the zodiac. The 5 Net Vertical Sampler (5NVS) and the double square nets were deployed during Leg 2a.

The specific objectives of Leg 2b was to;

- Train student on all spheres of oceanography from basic optics to ecosystem services. The main objective of the zooplankton team during this leg was to train student on different sampling method used for plankton studies. The 5 Net Vertical Sampler (5NVS)

including the LOKI (Imagery system) were deployed. Students were then able to compare those methods with other plankton sampling methods such as the UVP and IFCB. In addition, the Acoustic WBAT was deployed for Julek Chawarski Phd project in order to collect broadband backscatter of zooplankton and pelagic fishes.

The specific objectives of Leg 2c was to;

- Characterise the pelagic ecosystem of deep water region of the Northern Labrador Sea using multiple sampling tools such as the multinet sampler Hydrobios, the pelagic trawl IKMT, the UVP5 and the acoustic systems Wbat and Ek-60. This project was conducted by DFO. In addition, two additional monster net were deployed for Evan Edinger's team for isotopic analyses.

The specific objectives of Leg 3 were to;

- Compare zooplankton and fish species assemblages in different areas of the Kitikmeot, north west passages and Baffin Bay region, sampling at a range of water depths, and therefore water masses.
- Investigate the resilience of the marine calcifiying pteropod, *Limacina helicina* in undersaturated waters, particularly in the Queen Maud Gulf region.
- Sample microplastics via an underway outlet positioned subsurface at the stern of the Amundsen.

10.2 Methodology

10.2.1 *Double Square Net (DSN) (1 × 750µm, 1 × 500µm, 1 × 50µm)*

Description: Ichtyoplankton Net

Specifications: Rectangular frame carrying two 4.5m long, 1m^2 mouth aperture, square- conical nets and an external 10cm diameter, 50µm mesh net (to collect microzooplanktonic prey of the fish larvae). The DSN was equipped with three KC® flowmeters; one for the 750µm net, one for the 500µm net and a control flowmeter between the two nets.

Deployment: The sampler was towed obliquely from the side of the ship at a speed of ca. 2-3 knots to a maximum depth of 90m (depth estimated during deployment from cable length and angle; real depth obtained afterward from a Star-Oddi® mini-CTD attached to the frame).

Laboratory analyses: All fish larvae collected with the DSN were identified, measured and preserved individually in 95% ethanol + 1% glycerol. Zooplankton samples from the 500µm mesh and the 50µm mesh nets were preserved in 10% formalin solution for further taxonomic identification. The zooplankton from the 750µm mesh net was given to the contaminant team (Ainsleigh Loria, PI: Gary Stern) for mercury and pollutant analysis.

10.2.2 *5 Net Vertical Sampler (5NVS) (3 × 200µm, 1 × 500µm, 1 × 50µm)*

Description: Zooplankton sampler

Specifications: Four 1m^2 metal frames attached together and rigged with four 4.5m long, conical-square plankton nets, an external 10cm diameter, 50µm mesh net. The 5NVS was equipped with five KC Denmark ® flowmeters – each of the nets with a mesh size larger than 50µm was equipped with a flowmeter and a control flowmeter was attached on the centre of the frame.

Deployment: Deployed vertically from 10 meters off the bottom to the surface.

Laboratory analyses: After removal of any fish larvae/juveniles (identified, measured and preserved separately in 95% ethanol + 1% glycerol), zooplankton samples from the 500µm, 50µm and one of the 200µm mesh nets were preserved in 10% formaldehyde solution for taxonomic identification and count. The sample from the second 200µm mesh net was split into fractions (depending on the size of the sample); one fraction was preserved in ethanol for genetic analysis and a second fraction was divided into zooplankton smaller and larger than 1000µm, dried and frozen for biomass analysis. The third 200µm mesh net was checked for fish larvae and the zooplankton was disposed of afterward.

10.2.3 *Hydrobios (9 x 200 µm)*

Description: A multi-net plankton sampler

Specifications: The Hydrobios is equipped with nine 200µm mesh nets (opening 0.5m^2). This allows for depth specific sampling of the water column. The Hydrobios is also equipped with a CTD to record water column properties while collecting biological samples.

Deployment: The deployment is vertical from 15m off the bottom to the surface. The nets open and close one by one as the pressure decreases while the net is going up in the water column. The depth at which the different nets open and close is programmed before deployment.

Laboratory analyses: The zooplankton samples were preserved in 10% formalin solution for further taxonomic identification.

10.2.4 *Benthic Beam Trawl*

Description: Demersal fish sampler

Specifications: Rectangular net with a 3m^2 mouth aperture, 32mm mesh size in the first section, 16mm in the last section, and a 10mm mesh liner.

Deployment: The net was lowered on the seafloor and towed for 5 to 20 minutes at a speed of 3 knots.

Laboratory analyses: Adult fish collected with this sampler were identified, measured and stored at -200C while larvae were preserved in 95% ethanol + 1% glycerol.

10.2.5 *Ring Net*

Description: Small ichtyoplankton net

Specifications: 3.25m long conical net with a circular 65cm diameter opening and 500µm mesh size. A TSK flowmeter is attached to the opening.

Deployment: The ring net was deployed from the zodiac or barge in river estuaries or when heavy ice cover prevented the use of the DSN. The net is towed from the back of the zodiac at about 2 to 3kts, about 30m of rope is deployed.

Laboratory analyses: All fish larvae collected were identified, measured and preserved individually in 95% ethanol + 1% glycerol.

10.2.6 *Acoustic Monitoring*

The Simrad® EK60 echosounder of the Amundsen allows our group to continuously monitor the spatial and vertical distribution and biomass of zooplankton and pelagic fish that have a swim bladder such as cod (Boreogadus saida) and capelin (Mallotus villosus). The hull-mounted transducers are in operation 24h a day thus providing an extensive mapping of where the fishes are along the ship track.

10.2.7 *Microplastics Underway Sampler*

A simple modular device built at the BAS, Cambridge, UK, was connected to the underway outlet in the basin of science laboratory 610, pumping subsurface seawater from the bow of the ship. The water was filtered through 300, 100 and 50 µm nylon meshes sequentially (Figure 10.1). Water was run until the 50µm filter became clogged, hence showing highly variable sampling times and volumes (Figure 10.2). The benefit of this design compared with other large-volume water samplers is the reduced labour time and the enclosed design, limiting airborne contamination. A blank through clean filters was run, as well as GF/F filters left by the basin when the modules were opened. At the end of each sampling event, modules were disconnected and the mesh retaining the particulate, folded, placed into aluminium foil and ziplock bags and frozen in the -20 freezer, for further analysis back in Cambridge.

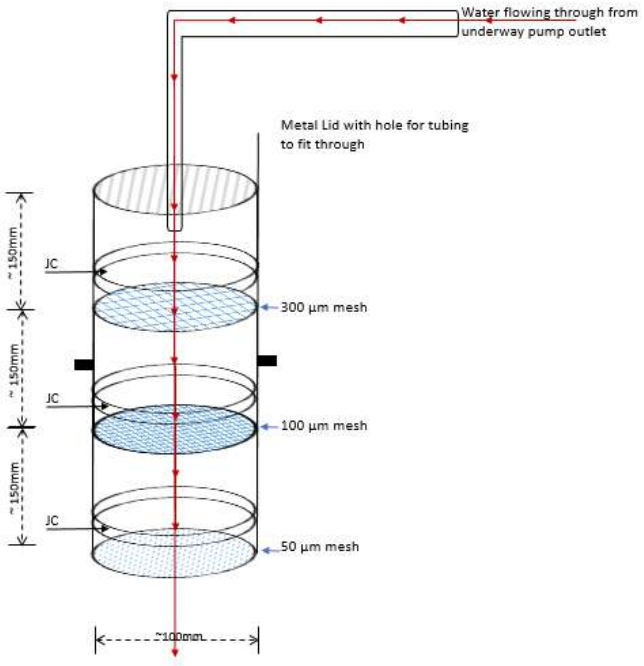

Figure 10-1 Microplastics underway filter tower schematic

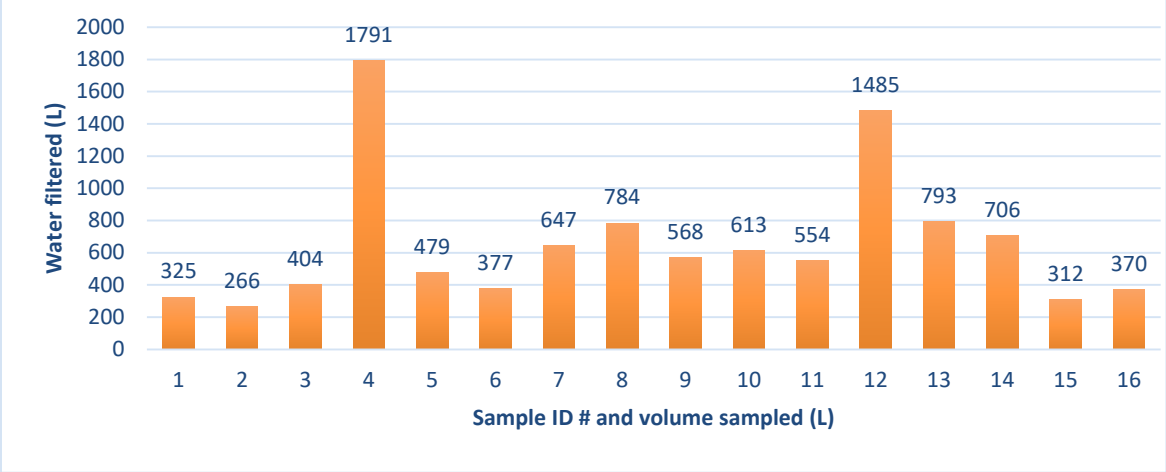

Figure 10-2 Volume of water sampled for each filter

10.2.8 *Wideband Autonomous Tranceiver (WBAT)*

Description: In complement to the traditionally used hull-mounted EK60 scientific echosounder, the broadband echosounder, an autonomous EK80 platform, offers a wide bandwidth frequency measurement of acoustic backscatter. While the hull-mounted EK60 operates at three discrete frequencies (38-, 120-, and 200- kHz), the WBAT measures backscatter at the 34-45 kHz range using a split-beam transducer, which allows for resolution and measurement of single targets. It also measures backscatter at the 283-383 kHz range using a single beam transducer. In combination, both wideband transducers provide frequency response curves and a high digitization rate for imaging midwater targets and aggregations of fish and zooplankton at deployed depths.

Specifications: The WBAT was mounted in a 4' x 1' x 1' steel mooring cage and transducers were mounted to steel plate on the underside. The entire package was hung vertically with transducers facing downward in the water. 1200-1500 broadband chirps were transmitted at each station with a 2s sampling interval to allow for phasing between 38 and 333 kHz transducers. Transducers were operated at 1.024 ms pulse lengths with 450 and 50 W power settings and data was recorded to 300m distance from the transducer.

Deployment: At each sampling station in the Labrador Sea, the WBAT was deployed to four discrete depths. First, the WBAT is deployed within 20m of the surface to collect data on the epipelagic layer and establish a baseline for change across the surface of the transect. Then, it is deployed to a depth between 100-200m, where it images a portion of the water not typically associated with high biomass. Finally, the WBAT is deployed lowered to a depth determined by viewing the live backscatter on the EK60. This portion of the water column typically contains strong scattering organisms, and is hypothesized to contain the bulk of the mesopelagic fish and zooplankton community. Due to differences in the vertical segregation across spatial and diurnal scales, distinct operational depths are decided at each station.

Laboratory analyses: Raw acoustic files will be analyzed by Julek Chawarski at the Marine Institute of Memorial University.

10.2.9 *Isaac-Kidd Midwater Trawl (IKMT)*

Description: Pelagic juvenile, adult fish and microzooplankton sampler

Specifications: Rectangular net with a $9m^2$ mouth aperture and mesh size of 11 mm in the first section, 5 mm in the last section.

Deployment: The net was lowered at a target depth which was determined by the echosounder Ek-60 signal and towed at that depth for 20 minutes at a speed between 2.5 -3.2 knots.

Laboratory analyses: Sample was sorted in the laboratory by species, counted and weighted. Fish were measured. Samples were split between DFO and Julek Charmanski and kept frozen for further analyses.

10.2.10 *Underwater Vision Profiler (UVP5)*

Description: The Underwater Vision Profiler is an imaging platform that captures images of both living and non-living particles in the water column. It can provide a wide range of measurements including particulate size, number, and density. The platform is integrated with an image classification program known as Ecotaxa. Using a machine learning image classification algorithm, it can identify individuals by taxa, such as copepoda and metazoa, and in some cases down to the species level.

Specifications: The UVP5 is mounted to the underside of the CTD-Rosette and collects over 10,000 images per cast. The housing is rated down to 4000m and includes a digital camera, two light bars, data storages drives, and communications ports. The control computer for the

UVP5 is in the rosette shack, where to operator can download data, charge the battery, and test the light system.

Deployment: At each rosette sampling station, as the rosette is lowered to its rinsing depth, the pressure sensor on the UVP5 initiates an image capture sequence. The UVP5 continuously captures images as particles moved through its light field on the downcast. A live-read out of particulate density is displayed on the rosette control screen, plotted alongside other variables such as temperature and salinity. Data was captured and download with each rosette cast. Metadata was entered at the end of each day into the zooprocess program and raw files were processed for future input into Ecotaxa.

Laboratory analyses: Data will be sent to an experienced Ecotaxa user and reviewed for misclassification. A portion of the data will be used to train future classification models. All post processing will be conducted by Marc Picheral, at IFREMR Villefranche. Classified data will be delivered to Julek Chawarski for further vertical and spatial analysis.

10.3 Preliminary results

10.3.1 *Leg 1*

Table 11-1 Summary of fish catches during Leg 1

Fish_family	Commun name	Adult	Larvae
Agonidae	Alligators Fish	106	62
Ammodytidae	Sandlance	8	274
Cottidae	Sculpins	45	742
Cyclopteridae	Lumpsuckers	8	3
Gadidae	Arctic Cod	62	43
Gasterosteidae			1
Liparidae	Snailfishes	55	149
Osmeridae	Capelin	5	13
Pholidae	Rock gunnel	2	3
Stichaeidae	Shannies	85	1066
Unidentified			73
Zoarcidae	Eelpouts	54	5

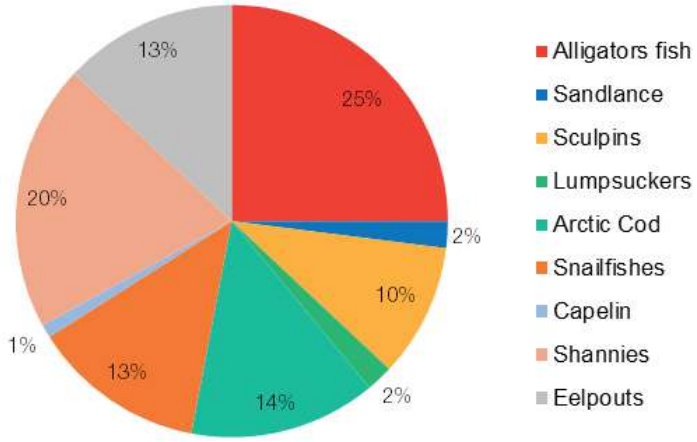

Figure 10-3 Adult fish species repartition (Leg 1)

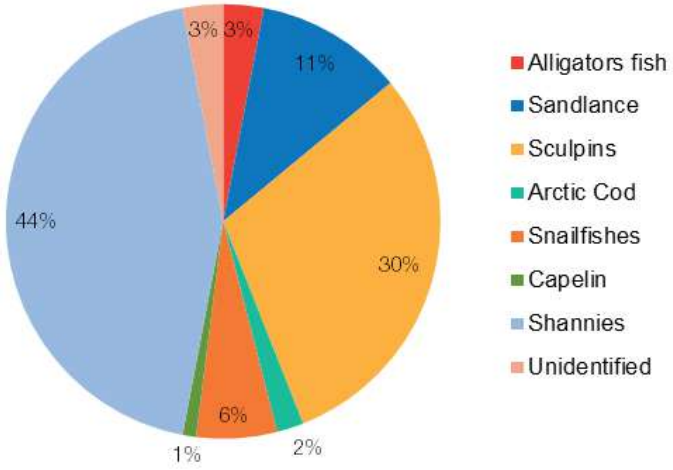

Figure 10-4 Fish larvae species repartition (leg1)

Table 11-2 Summary of net operations during Leg 1

Station	Sampling_date	4x1m2 (vertical)	2x1m2 (oblique)	Beamtrawl	Hydrobios	Ringnet 0.60m	Ringnet 1m
4	01-juin-18	●					
5	02-juin-18	●					
9	03-juin-18	●	●	●			
10	04-juin-18	●	●	●			
11	04-juin-18	●					
15	05-juin-18	●	●	●			
16	06-juin-18	●	●	●			
17	07-juin-18	●					
17a	07-juin-18					●	
17b	07-juin-18					●	
18	08-juin-18	●	●	●	●		
19	09-juin-18	●	●	●			
19c	09-juin-18					●	
21	10-juin-18	●	●	●	●		
22	11-juin-18	●	●	●			

22a	11-juin-18						●		
24	12-juin-18	●				●			
25	13-juin-18		●			●			
28	15-juin-18	●	●	●					
29	16-juin-18	●	●	●					
32	19-juin-18	●							
32a	19-juin-18						●		
34	21-juin-18		●						
36	22-juin-18	●				●			
38	23-juin-18		●						
40	24-juin-18	●							
43	27-juin-18		●	●					
44	28-juin-18		●	●		●			
45	30-juin-18			●					
46	01-juil-18	●	●	●					
BN3	30-juin-18							●	
BN5	30-juin-18							●	
BN7	30-juin-18							●	

10.3.2 *Leg 2*

Table 11-3 Summary of sampled fishes during Leg 2a

Fish Family	Adult	Larvae
Non-identified		461
Agonidae	1	4
Ammodytidae	7	20
Cottidae	8	92
Cyclopteridae	1	
Gadidae		25
Liparidae	1	266
Osmeridae		4
Pleuronectidae	1	
Stichaeidae	12	69
Total	31	941

Table 11-4 Summary of operations during Leg 2

Station	Sampling date	Tucker (2x1m2)	Monster (4x1m2)	Hydrobios (9x0.5m2)	IKMT	Ringnet 0.60m	Wbat	UVP 5
736	09-juil-18	●●	●					
736a	09-juil-18					●		
689a	11-juil-18					●		
341	12-juil-18	●●	●					
689	12-juil-18	●●	●					
IPS 1	16-juil-18		●				●	●
IPS 2	17-juil-18		●				●	●

IPS 3	18-juil-18	●				●	●
IPS 5	19-juil-18	●				●	●
IPS 4	21-juil-18	●				●	●
IPS 6	22-juil-18	●				●	●
DFO-1	29-juil-18		●			●	●
DFO-3	30-juil-18		●	●		●	●
DFO-750	31-juil-18		●	●		●	●
DFO-5	02-Aug-18		●	●		●	●
DFO-7	02-Aug-18		●	●		●	●
DFO-8	03-Aug-18		●	●		●	●
DFO-11	04-Aug-18		●			●	●
DFO-9	04-Aug-18		●	●		●	●
Hatton Basin	05-Aug-18	●				●	●
Lophelia	07-Aug-18	●				●	●

10.3.3 *Leg 3*

Table 11-5 Summary of net operations during Leg 3

Station	Sampling date	Tucker (2x1m2)	Monster (4x1m2)	Benthic Beam Trawl
312	19-juil-18	●	●	
QMG1	21-juil-18	●	●	●
QMG2	21-juil-18	●	●	
QMG4	22-juil-18	●	●	●
QMG3	22-juil-18	●	●	●
QMGM	22-juil-18	●	●	
101	28-juil-18	●	●	
115	29-juil-18	●	●	
177	01-Aug-18	●	●	

Table 11-6 Fish species sampled during Leg 3

Fish family	Commun name	Adult	Larvae
Agonidae	Arctic alligator fish		46
Cottidae		2	30
Gadidae	Arctic Cod	1	1049
Liparidae		2	60
Stichaeidae			158
Zoarcidae	Lycodes	5	
Unidentified			26

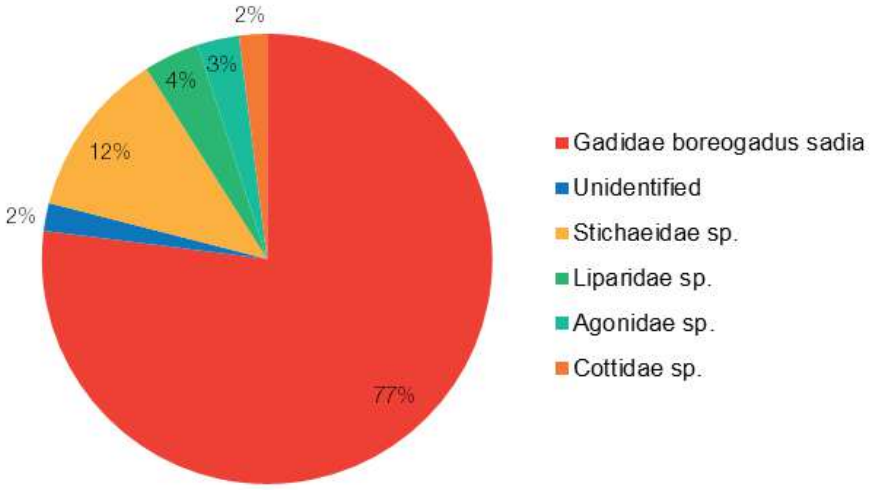

Figure 10-5 Adult Fish species repartition (Leg 3)

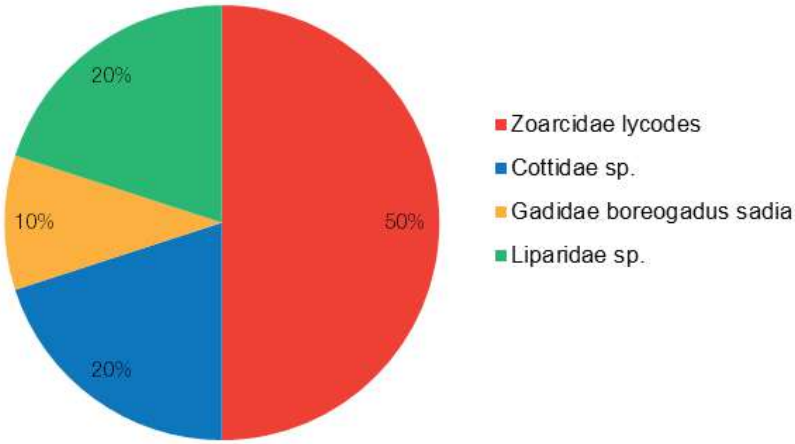

Figure 10-6 Fish Larvae species repartition (Leg 3)

Pteropod collection

Pteropods were collected from the 750µm mesh net oblique tow samples. Contents of the cod end were emptied into a cooled tray and all were specimens were picked. The condition of the shells were generally poor in terms of mechanical damage, which suggests this is an artefact of the sampling process. Individuals were removed via a wide-mouthed plastic pipette and dispensed in 1.5ml Eppendorf tubes containing RNAlater. Samples were then frozen in the -80°C freezer and will be analysed back at the BAS in Cambridge.

Table 11-7 *Limacina helicina* pteropod sample

Station	Date/Time	Lat	Long	Net/Mesh	Bottom Depth	Depth	#Vials	#Ptero-pods
312	19/08/18, 13:48:00 – 14:04:16	69.17323	-100.677	O- tow/ 750 µm	59m	0-40m	1	12*
							2	12*
							3	26*

QMG2	21/08/18, 10:40:07-10:49:22	68.31022	-99.8816	O- tow/ 750 µm	65-60m	50m	1	3
							2	10
							3	10
							4	10*
QMG4	22/08/18, 04:49:06-04:56:13	68.47668	-103.427	O- tow/ 750 µm	66-68m	50m	1	8
							2	15*
							3	14*
QMG3	22/08/18, 08:59:24-09:07:52	68.32418	-102.937	O- tow/ 750 µm	54-45m	30m	1	6
							2	15*
101	28/08/18, 12:56:08-01:12:06	76.38333	-77.382	O- tow/ 750 µm	357-336m	72m	1	5
							2	10*
115	29/08/18, 05:02:30-05:17:14	76.33624	-71.1991	O- tow/ 750 µm	667-654m	62m	1	3
							2	10*
							3	5*
	29/08/18, 13:15:26 – 13:56:10	67.475770	-63.69266	V-tow/ 200µm	667-654m	645m	4	10*
							5	3
							6	2*
177	01/09/18, 02:21:14-02:31:07	67.47825	-63.6418	O- tow/ 750 &500µm	652m	95m	1	8
							2	6*
							3	5
							4	5*

*Denotes pteropod of poorest quality – predominantly soft tissue.

10.4 Acknowledgement

We would like to express our sincere gratitude to the commanding officers Claude Lafrance and Alain Gariépy, and each one of the officers and crew members of the CCGS *Amundsen* onboard during the expedition. Kirstie would like to make special thanks to the Gerald Darnis, Louis Fortier and Alexandre Forest for the opportunity to work with the zooplankton team on this leg and for allowing her to collect microplastic samples along the way

11 Integrated Studies and Ecosystem Characterization of the Labrador Sea Deep Ocean – Leg 2c

Project leaders: David Côté[1] (David.Cote@dfo-mpo.gc.ca), Evan Edinger[2] and Annie Mercier[3]
Cruise participants – Leg 2c: Andrew Murphy[1], Camilla Parzanini[3]; Alec Aitken[4]; Anirban Chakraborty[5]; Gustavo Adolfo Guarin[6]; Meghan Hamp[4]; Karl Purcell, Catherine Young[3], Megan Dicker[7], Holly Hogan[8], Julek Chawarski[3], Thibaud DeZutter[6]
[1]*Fisheries and Oceans Canada, St. John's, NL, Canada*
[2]*Department of Geography, Memorial University of Newfoundland, St. John's, NL, Canada*
[3]*Department of Ocean Sciences, Memorial University of Newfoundland, St. John's, NL, Canada*
[4]*University of Saskachewan, Saskatoon, SK, Canada*
[5]*University of Calgary, Calgary, AB, Canada*
[6]*Biology Department, Université Laval, Quebec City, QB, Canada*
[7]*Nunatsiavut Government, General Deliverty, Nain, NL, Canada*
[8]*Environment and Climate Change Canada*

11.1 Introduction

The Government of Canada has committed to protecting 10% of Canada's marine and coastal areas by 2020 as part of its commitment to achieve international (the Convention on Biological Diversity 2011 20 Strategic Plan for Biodiversity's Aichi Targets) and domestic (2020 Biodiversity Goals and Targets for Canada) biodiversity conservation goals. In 2017, a three year study was initiated for a deep offshore portion of the northern Labrador Sea that was under consideration for a large offshore MPA. From an oceanographic perspective, the area is well studied and of global significance as it is one of the few areas of the world where deep-water convection occurs. However, at depths beyond 750 m, virtually no data was available regarding the biota. Consequently, the Integrated Studies and Ecosystem Characterization of the Labrador Sea Deep Ocean (ISECOLD) was initiated. A CSAS meeting in 2017 (Cote et al. 2018) highlighted the need for characterization efforts related to benthic and pelagic communities, demersal fish communities, seabed mapping and habitat characterization and seabird and marine mammal observations. The Amundsen 2018, Leg 2C Expedition addresses these target areas with the exception of demersal fish; a program component for which an alternative vessel and sampling techniques are required.

The general methods used to achieve this characterization include water and sediment sampling, acoustic mapping and fish/plankton surveys, sea bottom imaging (ROVs/drop cameras), long term deployments of environmental sensors and visual observations of sea-birds and marine mammals. These program elements are highlighted in greater detail below. Sample locations are provided in Figure 11.1 and Figure 11.2.

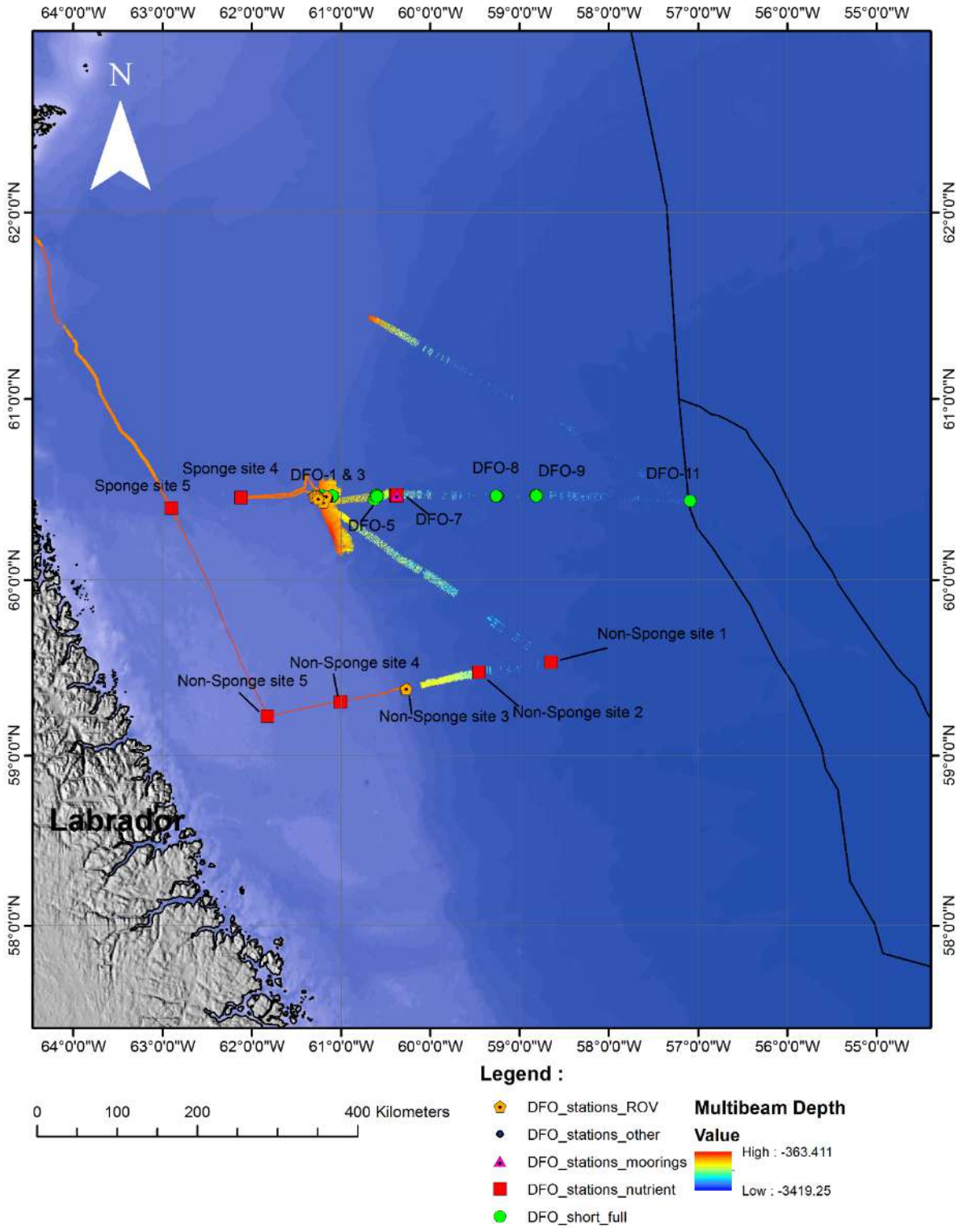

Figure 11-1 ISECOLD sampling sites during Leg 2C of the 2018 Amundsen cruise.

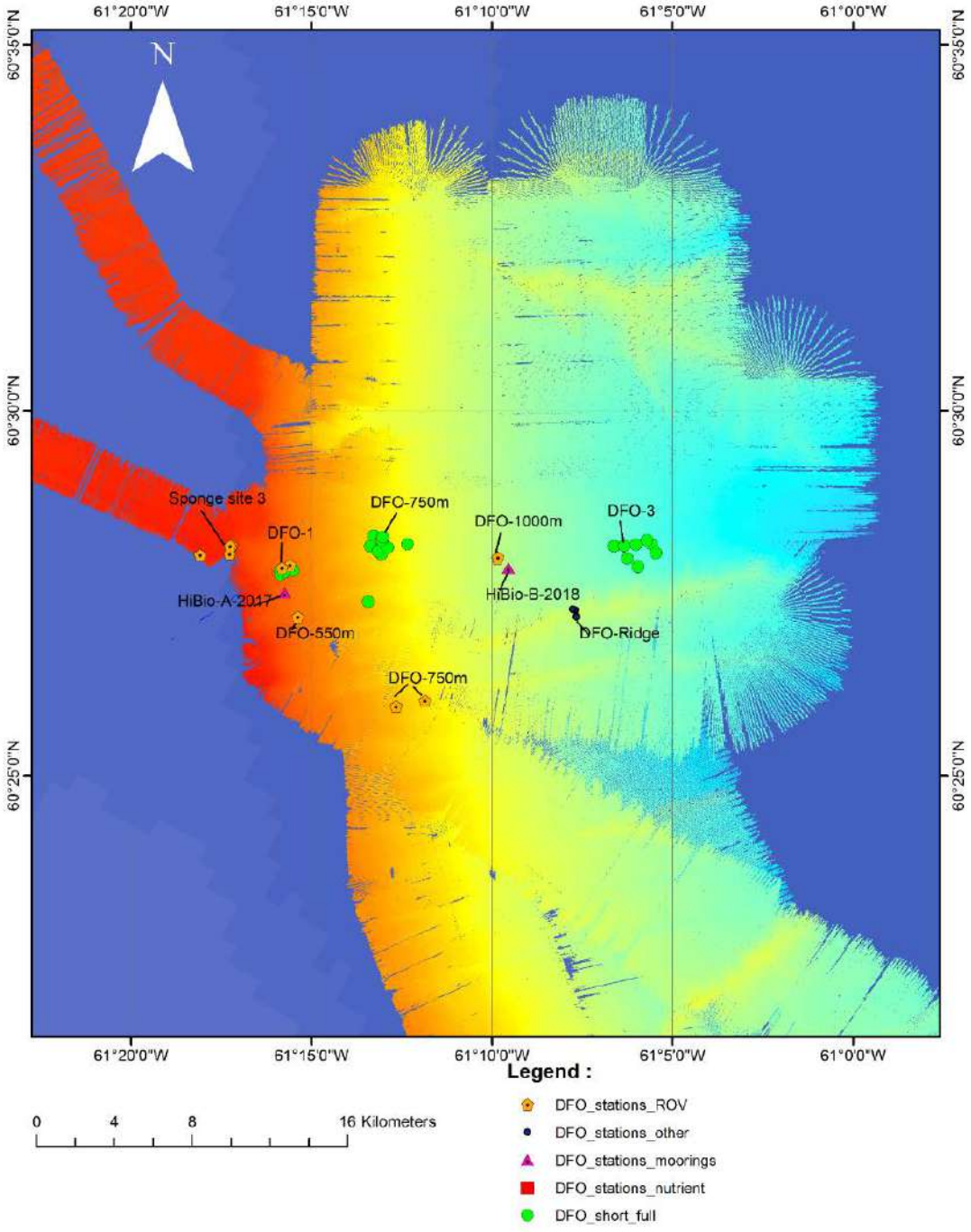

Figure 11-2 ISECOLD sampling sites along the shelf break and slope superimposed upon multibeam mapping imagery.

11.2 Methodology

11.2.1 *Water Sampling*

Seawater was collected at each DFO station using a CTD-Rosette water sampling system comprised of twenty-four 12L Niskin bottles. A variety of scientific analyses were conducted on

these samples, and with the exception of environmental DNA, these activities (e.g. nutrient analyses) are covered in the water sampling project reports (Shaomin Chen).

11.2.2 *eDNA Analysis of Water*

Environmental DNA is an emerging scientific tool that uses DNA fragments shed from animals into the water column to characterize biotic community composition. The technique has promise as a non-invasive approach that is complimentary to other conventional methods, particularly in the deep sea where specimens are very difficult to collect. To characterize benthic and pelagic faunal communities water samples were collected from the surface, midwater (hydro-acoustic deep scatter layer (DSL), and upper deep scatter layer (UDSL)) and the ocean bottom. These depths were selected to match other sampling activities (bottom camera, box core, plankton nets and IKMT trawls) that could be used to validate/compare results. In addition to DFO stations, collections were made at other Leg 2c study areas including Hatton Basin, West Greenland and Scott Inlet.

Prior to the CTD-Rosette deployment, the inside and upper and lower lids of the Niskin bottles were sprayed first with a DNA removal solution and then rinsed with distilled water. In order to reduce the possibility of the bottles being contaminated, latex gloves were worn during this procedure and care was taken not to breathe on the Niskin bottles. The bottles were also closed up after they were cleaned until deployment to prevent contamination.

Once the vessel reached the selected sampling station, the CTD-Rosette was lowered from the vessel on a winch system and was programmed to open and close at several different depths, each collecting seawater at its respective depth. Water was collected at the ocean surface, bottom and midwater (targeted to deepwater scattering layer depths determined by visual interpretation of EK60 sounder graphs). A blank sample comprised of distilled water was also collected at intervals to serve as a control to assess potential contamination during subsequent laboratory analyses. Once the CTD-Rosette was brought back on board the vessel, priority was given to DFO study participants to sample the Niskin bottles to prevent accidental contamination by other study team members. Once again, latex gloves were used to collect three replicate samples from each sample depth in pre-labeled sterilized 250 mL bottles. These samples were placed in pre-labled Zip-loc bags and placed in a chest freezer and frozen.

In total, 14 stations were sampled for eDNA water sample collection (Table 10.1). Overall, the bottom layer, DSL, upper DSL and surface were sampled for all stations except for DFO-1, DFO-7, and DFO-8, where the upper DSL was excluded, and stations “Greenland2”/NLSE07, SW Greenland 2, and Scott Inlet where both the DSL and upper DSL were excluded due to shallow water depths. As previously mentioned, these water samples will be analyzed for eDNA by CEGA.

Table 12-1 List of Sampling Stations for eDNA Water Sampling for Leg 2c of 2018 Amundsen Expedition

Station	Cast #	Deployment GPS Position	Recovery GPS Position	Date	Time (UTC)	Bottle number	Sample Layer	Depth (m)
DFO-1	27	60.46346, -61.26449	60.46451, -61.27196	07/29/2018	22:57:37	1	Bottom	505.955
				07/29/2018	23:04:49	12	DSL	396.481
				07/29/2018	23:38:02	24	Surface	2.676
DFO-3	30	60.4663, -61.10411	60.46433, -61.11693	07/31/2018	1:26:34	1	Bottom	1122.307
				07/31/2018	1:40:38	12	DSL	594.2
				07/31/2018	1:51:22	18	Upper DSL	249.61
				07/31/2018	2:03:52	24	Surface	2.779
DFO-750	31	60.46723, -61.21773	60.45754, -61.22463	07/31/2018	23:58:15	1	Bottom	705.819
				08/01/2018	0:07:19	12	DSL	497.044
				08/01/2018	0:15:34	18	Upper DSL	246.885
				08/01/2018	0:26:44	24	Surface	2.271
DFO-5	32	60.46687, -60.59771	60.45852, -60.61084	08/02/2018	0:52:16	1	Bottom	1418.474
				08/02/2018	1:12:06	12	DSL	500.539
				08/02/2018	1:17:24	18	Upper DSL	299.168
				08/02/2018	1:24:33	24	Surface	2.442
DFO-7	33	60.46692, -60.38003	60.46576, -60.39252	08/02/2018	17:57:05	1	Bottom	1877.522
				08/02/2018	18:30:44	12	DSL	495.005
				08/02/2018	19:00:10	24	Surface	2.701
DFO-8	34	60.46845, -59.25748	60.46654, -59.24244	08/03/2018	8:18:53	1	Bottom	2428.178
				08/03/2018	8:57:23	12	DSL	495.151
				08/03/2018	9:36:41	24	Surface	2.534
DFO-9	35	60.47102, -58.81319	60.47807, -58.8122	08/03/2018	23:30:09	1	Bottom	2502.175
				08/04/2018	0:20:53	12	DSL	495.709
				08/04/2018	0:30:29	18	Upper DSL	247.974
				08/04/2018	0:47:57	24	Surface	1.915

DFO-11	36	60.44128, -57.09002	60.45326, -57.08169	08/04/2018	11:14:47	1	Bottom	3008.101
				08/04/2018	12:15:30	10	DSL	497.277
				08/04/2018	12:25:40	18	Upper DSL	248.489
				08/04/2018	12:44:19	24	Surface	4.726
Hatton Basin	37	61.43727, -60.66732	61.43378, -60.67197	08/05/2018	5:48:17	1	Bottom	594.236
				08/05/2018	5:52:58	12	DSL	494.168
				08/05/2018	6:03:29	18	Upper DSL	246.741
				08/05/2018	6:21:49	24	Surface	2.864
Greenland1/Lophelia1	40	60.36635, -48.45729	60.37645, -48.47018	08/07/2018	0:40:12	1	Bottom	715.554
				08/07/2018	0:50:36	12	DSL	494.252
				08/07/2018	0:58:02	18	Upper DSL	247.041
				08/07/2018	1:11:45	24	Surface	2.55
"Greenland2"/NLSE07	42	60.36933, -48.45723	60.37882, -48.47139	08/09/2018	15:40:45	1	Bottom	1161.792
				08/09/2018	16:39:08	24	Surface	2.278
SW Greenland 1	43	63.99804, -55.50314	63.99629, -55.51477	08/09/2018	22:10:16	1	Bottom	1064.584
				08/09/2018	22:30:08	12	DSL	445.273
				08/09/2018	22:38:39	18	Upper DSL	247.617
				08/09/2018	22:54:32	24	Surface	2.129
SW Greenland 2	44	66.49895, -57.00849	66.49952, -57.03079	08/10/2018	12:02:29	1	Bottom	648.067
				08/10/2018	12:40:00	24	Surface	2.462
Scott Inlet	47	N/A	N/A	08/12/2018	12:29:34	1	Bottom	238.273
				08/12/2018	13:03:54	24	Surface	2.755

Note: Deployment and Recovery GPS Position data for the CTD-Rosette were obtained from the wheelhouse of the CCGS *Amundsen*. No GPS position was available for the Scott Inlet sampling site prior to the submission of field report.

11.2.3 *Multi-beam Habitat Mapping*

Multibeam habitat mapping was conducted during all activities within the Labrador Sea study area (Figure 12.1 and Figure 12.2), except in cases where operational requirements required that it be turned off (i.e. when HIPAP was in use for drop camera and ROV activities). Details of the habitat mapping are provided in the multibeam cruise report (L. Arduini Plaisant).

11.2.4 *Long Term Deployments of Environmental Sensors*

Long term deployments of moorings and landers provide an opportunity to use data logging sensors to acquire temporal data series of environmental conditions in the study area. Such data is particularly valuable for understanding natural cycles and temporal variation, which is not possible from the typical point sampling activities that occur within the timeframe of the cruise. Moorings deployed as part of the ISECOLD program (detailed in the ISECOLD Moorings Cruise Report, S. Meredyke) contained instruments such as an Autonomous Marine Acoustic Recorder (whales and anthropogenic noise), a sediment trap (food and sediment delivery to sea floor and plankton community dynamics), an ADCP (bottom currents and temperature), and an IN DEEP larval settlement apparatus. Two such moorings were deployed at DFO 3 (1000 m) and DFO 7 (1855 m). One additional mooring was retrieved from DFO-1 Saglek Bank in ~509m of water (deployed on October 7, 2017). Additionally two ATLAS landers, containing similar instrumentation, were deployed at DFO 1 and at the ATLAS non-sponge site.

The following describes the activities related to the deployment, recovery and processing of the settlement plates, which were designed to investigate and assess the settlement of deep-sea organisms (early life stages, e.g. eggs, propagules and larvae, as well as juveniles and adults).

During Leg 2c of the Amundsen 2018 expedition, a settlement apparatus deployed October 7th, 2017 was recovered from station DFO 1 (Table 12.2, Figure 12.3, Figure 12.4) on July 31st, 2018. Once recovered, the frame was dismantled, and each substrate cube placed in different jars under ethanol 70% for further analysis at the Department of Ocean Sciences, Memorial University of Newfoundland (Canada). Preliminary examination of the settlement apparatus resulted in observations that the substrate was colonized by hydrozoans (Figure 12.5). However, detailed analysis remains to be conducted.

Three new settlement apparatuses were also deployed at three stations ranging from 405 m to 1855 m (Table 12.3). Two of the new deployments were placed on ISECOLD moorings (Figure 12.6, Figure 12.7) whereas the third was placed on an ATLAS lander (Figure 12.8, Figure 12.9, Table 12.3). No larval settlement apparatus was placed on the second ATLAS lander.

Table 12-2 Details of the recovery of the settlement plate deployed in October 2017, during a previous Amundsen expedition.

	RECOVERY
Position (D DM)	60° 27.6464' N – 61° 15.7307' W
Station ID	DFO-1, HiBioA-17
Depth (m)	508
Date (dd/mm/yy)	31/07/18
Time (approximate)	3:10 PM

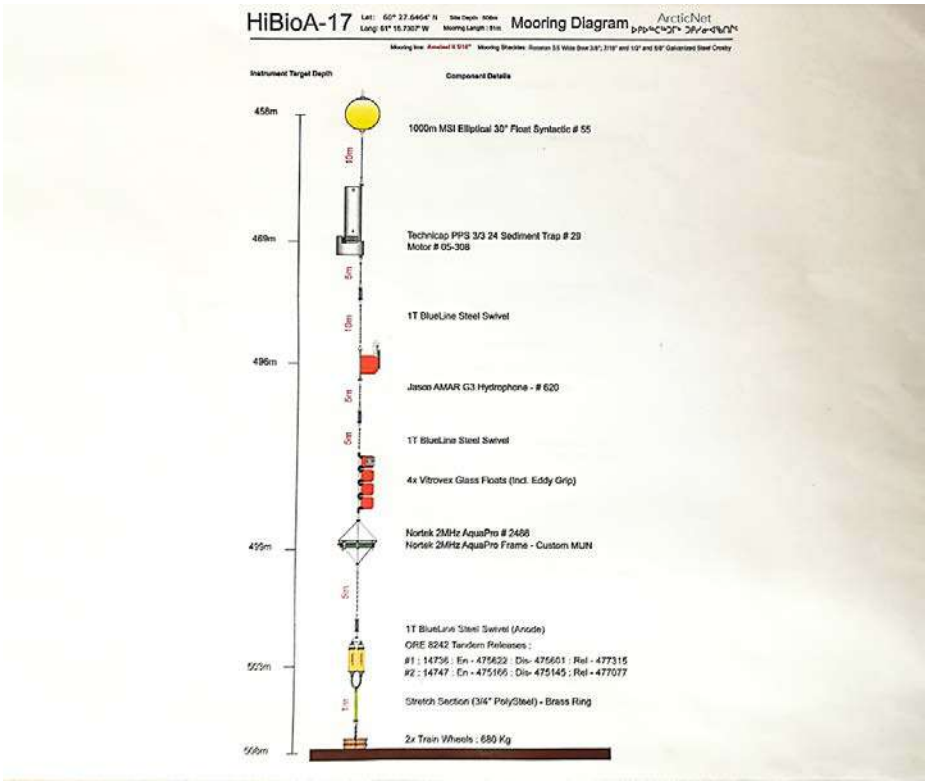

Figure 11-3 Scheme of the mooring deployed on October 7th, 2017 in HiBioA-17.

Figure 11-4 Recovery of the mooring and settlement plate from the station HiBioA-17.

Figure 11-5 Settlement apparatus recovered from the site HiBioA-17 with colonies of hydrozoans attached.

Figure 11-6 Deployment of mooring and settlement plate in HiBioB-18

Figure 11-7 Settlement plate deployed on July 30th, 2018.

Table 12-3 Details of the deployment of the new settlement apparatuses.

	DEPLOYMENT		
	Site 1	Site 2	Site 3
Position (Degrees)	60.46738°N 61.28785° W	60.46406°N 61.15908° W	60.47365°N 60.37526°W
Station ID	Sponge Site 3	DFO-3, HiBioA-18	DFO-7, HiBioB-18
Depth (m)	405	1000	1855
Date (dd/mm/yy)	30/07/18	01/08/18	02/08/18
Time (approximate)	2:31 PM	5:21 PM	1:55 PM

Figure 11-8 Operations during the deployment of lander and settlement apparatus attached, on July 30th, 2018.

11.2.5 *Drop Camera/ROV*

Drop camera (stations >1000m) and Remotely Operated Vehicles (ROVs; stations <1000m) were included in the study design to characterize benthic fauna and habitat and, in the case of ROVs, to sample corals and sponges. Separate cruise reports describe the ROV activities (ROV report, E. Edinger) and drop camera activities in Frobisher Bay (Alec Aitken report) and the Lophelia Site (E. Edinger et al. report) in detail. The section describes activities related to the drop camera for the ISECOLD project.

The deep-sea camera system was comprised of two cameras (a SubC deep water camera and Sony 4K camera), LED lights and a HIPAP sensor, which were attached to a box core frame (Figure 11.10). The latter was used to provide the camera team with the real-time data of the camera position (relative to the vessel) as well as exact position of the camera relative to the seabed. Specific GPS coordinates of sampling stations for drop camera surveys can be seen in Table 11.4.

The box corer apparatus containing the drop camera setup was attached to a winch cable system and lowered from the vessel at 60 m/min. When the drop camera was within ~50 m from the last reported depth, it was lowered at 20 m/min until it touched bottom. The camera lead would communicate if the drop camera was on the seabed via observation of the HIPAP software but generally the deckhand operating the winch could determine if the camera was on bottom by examining the tensiometer on the winch, which would show a drop in tension when the drop camera system touched the bottom. From there on, a “yo yo” method was employed whereby the camera would be raised 2 – 5 m off the bottom (as measured by the length of winch cable retracted), and dropped on the bottom again, and this procedure was typically repeated for 30 minutes (but ranged from 15 – 60 minutes, depending on the sampling site).

A record was kept of the time of the camera deployment, time on bottom, time removed from bottom, and time that the camera was lifted back on the deck. Once the camera was back on deck, the camera setup was rinsed with fresh water, removed from the box core, and taken to the foredeck lab to have the video footage from both the SubC camera and the Sony 4K camera downloaded and saved to an external hard drive.

Seventeen drop camera deployments were conducted during Leg 2c of the 2018 Amundsen Expedition, of which 8 were used for the ISECOLD project. Footage from the SubC drop camera has been preliminarily viewed for all sampling stations.

Camera footage was generally of good quality across most of the sampling stations however there were a few stations which provided occasionally poor observational coverage, primarily due to the camera view being obscured by sediment plumes or the camera moving too fast or being too high off the seabed. Drop camera surveys for the ISECOLD project ranged in depth from 546 to 2523 m. Stations DFO-10 (2750m) and DFO-11 (3000m) were not sampled as there was insufficient cable on the winch to reach bottom. In general, the sampling stations that occurred on hard bottom tended to have higher epifauna productivity in comparison to the soft

bottom stations as observed by the abundance and distribution of marine megafauna/flora from those drop camera video transects.

Generally, sponges, corals, and brittle stars tended to dominate the epifauna of several soft bottom sites as well as the majority of hard bottom sites (Table 11.5, Figure 11.11). There were many different species of sponges (e.g. Tetilla c.f. sibirica, Geodia sp., Chondrocladia sp., Asconema sp.) and corals (Gersemia sp., Anthomastus sp.) encountered throughout the study, however many more coral and sponge species remain to be identified in the aftermath of this survey. These taxa were observed out to the deepest sites surveyed (~2500m).

Fish species were also encountered during the survey. The primary species identified were grenadier however blue hake, lanternfish and other yet to be identified fish species were also observed. Cephalopods, including species of squid, spoon arm octopi and a dumbo octopus, were seen throughout different video transects, and three decapod species (two species of crabs and squat lobsters) were also sighted at the sampling stations. Other organisms that were observed throughout the sampling period include: anemones, cerianthids, ascidians, sea stars (many different species; including basket stars), bryozoans, sea urchins, crinoids, stocked crinoids, sea spiders, shrimps, gastropods, isopods, bivalves, sand dollars, and a tube worm (Figure 11.10).

Figure 11-9 Drop Camera system attached to box core utilized in Leg 2c of the 2018 Amundsen Expedition.

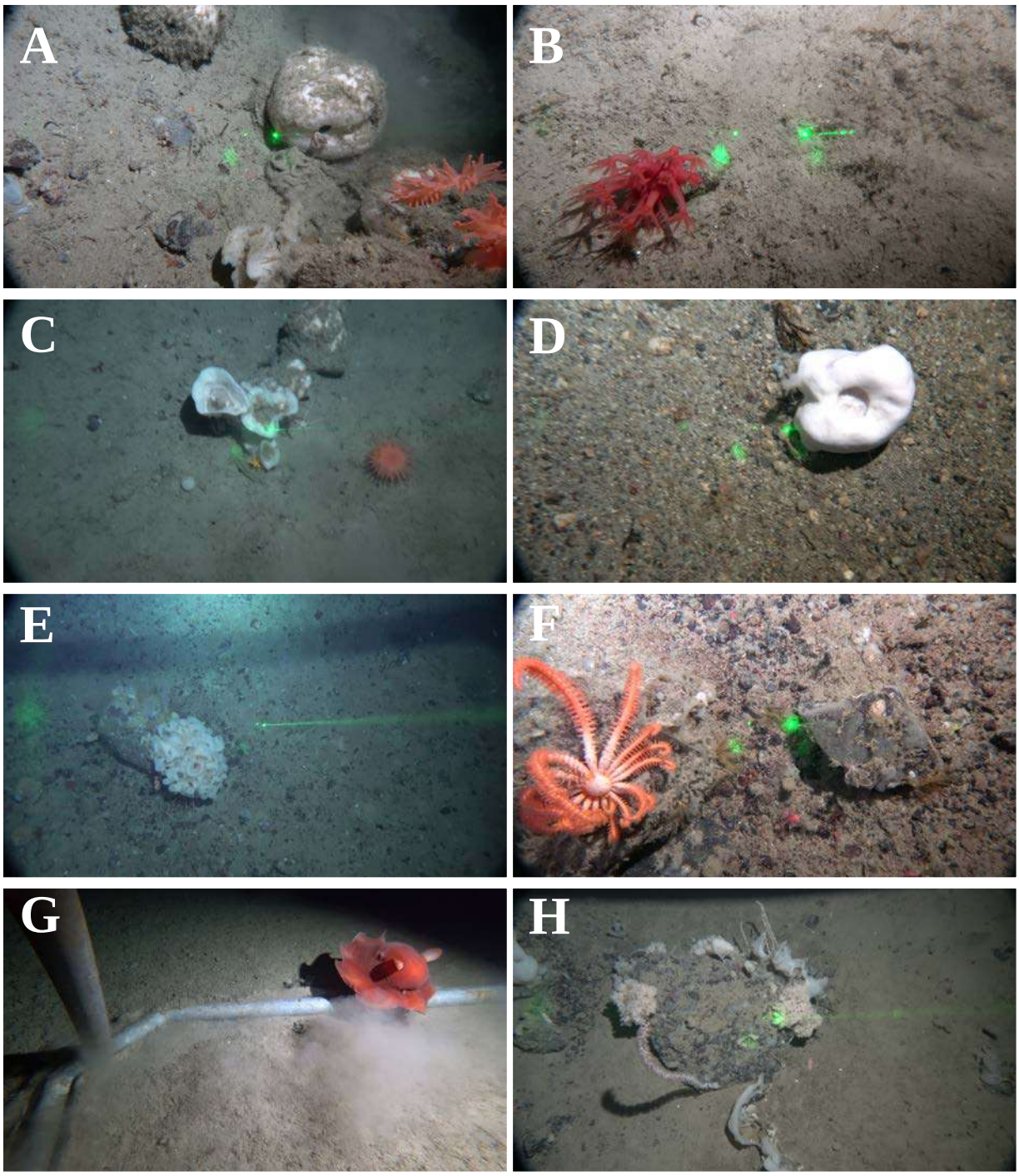

Figure 11-10 Photo captures of drop camera video from DFO station video transects.
A: Geodia sp. and anemone (DFO-3); B: Anthomastus sp. (DFO-3); C: Unidentified cup coral and anemone (DFO-3); D: Unidentified sponge sp. (DFO-750); E: Asconema sp. (DFO-Ridge 1000); F: Sea star (DFO-Ridge 1000); G: Dumbo octopus (DFO-5); H: Various coral and sponge species (DFO-9).

Table 12-4 List of Drop Camera Sampling Stations for Leg 2c of the 2018 Amundsen Expedition.

Dep #	Station ID	GPS Coordinates on Bottom (Start)	GPS Coordinates on Bottom (End)	Date	Time Deployed	Time on Bottom	Time Retrieved from Bottom	Time on Bottom (min)	Bottom Depth
9	Non-Sponge Site 3	59.38067, -60.27671	59.37706, - 60.28005	07/28/2018	12:14	12:25	13:12	47	546 m
10	DFO-3	60.46917, -61.10557	60.46911, - 61.11023	07/30/2018	22:40	22:57	23:28	31	1166 m
11	DFO-750	60.47115, - 61.2172	60.46955, - 61.2057	07/31/2018	12:52	13:15	14:15	60	770 m
12	DFO-Ridge 1000	60.4545, - 61.12836	60.45301, - 61.12762	08/01/2018	10:30	10:59	11:30	31	1009 m
13	DFO-5	60.47636, - 60.60635	60.47605, -60.60569	08/02/2018	4:26	4:51	5:22	31	1424 m
14	DFO-7	60.46786, -60.37504	60.46647, - 60.383	08/02/2018	10:55	11:36	12:09	33	1930 m
15	DFO-8	60.46852, -59.26094	60.46862, - 59.26321	08/03/2018	1:16	1:59	2:30	31	2443 m
16	DFO-9	60.46764, -58.81365	60.46882, - 58.81518	08/03/2018	16:16	17:02	17:33	31	2523 m
17	Lophelia Site/Greenland 1	60.37282, - 48.47534	60.37264, - 48.48534	08/07/2018	4:40	4:55	5:25	30	630 m

Note: *Only GPS coordinates for drop camera deployment and retrieval were available for Sampling Station 13c; no bottom coordinate data.

Deployment and Recovery GPS Position data for the drop camera were obtained from the wheelhouse of the CCGS *Amundsen*. Deployments 1-8 were conducted as part of the Frobisher Bay project.

Table 12-5 General Description of Drop Camera Sampling Stations by Bottom Depth, Bottom Type, Video Quality, Biological Productivity, and Megafauna/flora observed from preliminary observation of Drop Camera Footage for Leg 2c of the 2018 Amundsen Expedition.

Dep #	Station ID	App. Bottom Depth	Bottom Type	Video Quality	Biological Productivity	Megafauna/flora observed
9	Non-Sponge Site 3	546 m	**Soft bottom**; muddy, silty sediment; some small rocks, cobble, and pebbles; few medium and large rocks/boulders.	**Good:** Visibility and camera height off bottom were adequate.	**Low:** Low abundances of organisms and sparse distribution throughout video transect.	**Somewhat common:** Sponges, corals, anemones, sea stars, unidentified crab sp. **Uncommon:** Bryozoans, fish (unidentified fish sp., and grenadier), octopus,

						kelp, ascidians, crinoids, shrimp.
10	DFO-3	1166 m	**Soft bottom**; muddy sediment, some medium and large rocks/boulders.	**Good:** Visibility and camera height off bottom were adequate.	**Low:** Low abundances of organisms and sparse distribution throughout video transect.	**Common:** Sponges, corals, anemones, bryozoans, ascidians, brittle stars, sea stars. **Uncommon:** fish (grenadier and possibly a blue hake), gastropods.
11	DFO-750	770 m	**Hard bottom**; many small rocks, pebbles, cobble, with some medium/large rocks and boulders throughout.	**Good:** Visibility and camera height off bottom were adequate.	**Medium:** An intermediate abundance of organisms and moderate distribution throughout video transect.	**Common:** Sponges, corals. **Uncommon:** anemones, bryozoans, ascidians, gastropods, fish (a grenadier, and possibly a lanternfish), crab (possibly a porcupine crab), sea stars, brittle stars, bivalves, octopus.
12	DFO-Ridge 1000	1009 m	**Hard bottom**; many small rocks, pebbles, cobbles, with some medium and large rocks/boulders throughout. Transition to silty substrate towards the end of the video transect.	**Good:** Visibility and camera height off bottom were adequate.	**Medium:** An intermediate abundance of organisms and moderate distribution throughout video transect.	**Common:** Sponges, corals, anemones, bryozoans, ascidians. **Somewhat common:** Crinoids. **Uncommon:** Gastropods, tube worm, brittle stars, sea stars, octopus, squid.
13	DFO-5	1424 m	**Soft bottom**; muddy sediment, some medium and large rocks/boulders.	**Good:** Visibility and camera height off bottom were adequate.	**Low:** Low abundances of organisms and sparse distribution throughout video transect.	**Somewhat common:** Sponges, corals, anemones. **Uncommon:** bryozoans, sea urchins, brittle stars, sea stars, fish (possibly a grenadier, snipe

						eel, and a rockling), dumbo octopus.
14	DFO-7	1930 m	**Soft bottom**; muddy sediment, some medium and large rocks/boulders.	**Good:** Visibility and camera height off bottom were adequate.	**Low:** Low abundances of organisms and sparse distribution throughout video transect.	**Somewhat common:** Brittle stars, sea stars. **Uncommon:** Sponges, stocked crinoids, corals, anemones, sea urchins, shrimp, fish (possibly a blue hake, and a rockling).
15	DFO-8	2443 m	**Soft bottom**; muddy sediment.	**Poor:** Sediment plumes obscured camera view.	**Low:** Low abundances of organisms and sparse distribution throughout video transect.	**Uncommon:** Sponges, shrimp, brittle stars, ascidians, and bivalves.
16	DFO-9	2523 m	**Soft bottom**; muddy sediment, small rocks.	**Very poor:** Sediment plumes obscured camera view, and camera had difficulty finding bottom.	**Low:** Low abundances of organisms and sparse distribution throughout video transect.	**Uncommon:** Sponges, corals, sea stars, fish (possibly a grenadier and a snipe eel).
17	Lophelia Site/Greenland 1	630 m	**Hard bottom**; gravel, silt, many small rocks, pebbles, cobbles; many medium and large rocks/boulders.	**Satisfactory:** Camera was dragged rapidly along bottom for lengthy periods. Improvement observed in the latter half of the video.	**High:** High abundances of organisms and diverse distribution throughout video transect.	**Common:** Sponges, corals, bryozoans, ascidians, brittle stars, fish (redfish, and grenadier). **Uncommon:** Fish (cusk, unidentified fish sp.), anemones, sea urchins, bivalves, gastropods.

Note: deployments 1-8 were conducted as part of the Frobisher Bay project.

11.2.6 *Box Coring*

To investigate biodiversity of epifaunal and infaunal communities of the ocean bottom, sediment samples were collected by box cores between July, 31st to August 3rd, 2018. Once cores (50x50 cm) were recovered onboard, pictures of the sediment were taken (Figure 11.12), and 3 replicates of approximately 5 g each of undisturbed sediment surface were collected for eDNA analysis. These sediment samples were placed in clean labelled Whirl-pak bags and immediately frozen at -80°C. Further analysis will be conducted at the Centre for Environmental Genomics Applications, on behalf of Fisheries and Oceans (DFO), St. John's, NL. In addition, 3 more scoops of sediment (~ 8/9 grams each) were collected for isotopic analysis, and frozen at -20°C. Isotopic analysis will be carried out at the CREAIT Terra Facility at Memorial University, St. John's, NL, as part of a concurrent study of Master student (C. Young). A volume of 25x50x15 cm of sediment was then sampled and sieved through a 0.5 mm fine mesh. As there was not enough material within the core retrieved in station DFO-7, a volume of 25x50x11 cm of sediment was collected instead, for that station. The remaining core was sampled by various research teams. All the sieved material was eventually gathered into jars and stored under 4% formalin for 48 hours, which was then replaced with 70% ethanol, for subsequent analysis at Fisheries and Ocean, St. John's, NL. In cases in which large corals, sponges, and other invertebrates were found within the box core samples, as part of concurrent studies, these organisms were immediately retained, measured, and recorded, before storage (70% ethanol, 4%formalin and/or frozen at -20°C). Sampled corals and sponges will be processed by the ATLAS group, whereas echinoderms and other invertebrates will be sent to the Mercier Lab, Department of Ocean Sciences, at Memorial University, NL (Figure 11.12).

Table 12-6 Station ID of the box core sampling, together with date, geographic coordinates, depth, number and type of samples collected for the further analysis.

Stn	Date (dd/mm/yy)	Position (Degrees)	Depth (m)	Samples collected	Project/Analysis	Notes
DFO-3	31/07/2018	60.46958°N - 61.20946°W	1162	4 jars (various volume) of seived material	Biodiversity assessment (DFO*)	Muddy bottom containing a few big rocks
				3 replicae of surface sediment	eDNA (CEGA*)	
				1 replicae of surface sediment	Stable Isotope Analysis (CREAIT, MUN*)	
DFO-5	02/08/2018	60.46839°N - 60.58490°W	1424	3 jars (various volume) of seived material	Biodiversity assessment (DFO*)	Muddy bottom
				3 replicae of surface sediment	eDNA (CEGA*)	
				3 replicae of surface sediment	Stable Isotope Analysis (CREAIT, MUN*)	
DFO-7	02/08/2018	60.47590°N - 60.37512°W	1899	11 jars (various volume) of seived material	Biodiversity assessment (DFO*)	Muddy bottom; Only a volume of 25x50x11 cm of sediment was sieved
				3 replicae of surface sediment	eDNA (CEGA*)	
				3 replicae of surface sediment	Stable Isotope Analysis (CREAIT, MUN*)	
				2 Ophiuroidea sp 1 (~1 g)	Reproduction (OSC, MUN*)	
				1 Ophiuroidea sp 2 (< 1 g)	Reproduction (OSC, MUN*)	
				1 Sea anemone sp. (~2 g)	Reproduction (OSC, MUN*)	
				5 Polychaeta spp. (~1 g)	Reproduction (OSC, MUN*)	
				1 Paramuricea sp. (< 1 g)	Reproduction (OSC, MUN*)	
				2 Ophiuroidea spp. (< 1 g)	Reproduction (OSC, MUN*)	
				1 piece of sponge sp. (< 1 g)	Reproduction (OSC, MUN*)	
				1 brachiopoda sp. (~1 g)	Reproduction (OSC, MUN*)	
				1 Acanthogorgia (3 g)	ATLAS	
				1 Anthomastus (11 g)	ATLAS	
				1 sponge or ascidian (1 cm^3)	ATLAS	
				1 sponge sp (3 g)	ATLAS	
DFO-8	03/08/2018	60.46771°N - 59.24516°W	2445	2 jars (various volume) of seived material	Biodiversity assessment (DFO*)	Muddy bottom containing plenty of foraminiferan shells
				3 replicates of surface sediment	eDNA (CEGA*)	

				3 replicates of surface sediment	Stable Isotope Analysis	
				1 Ophiuroidea sp.1 (~1 g)	Reproduction (OSC, MUN*)	
* Fisheries and Oceans (DFO); Centre for Environmental Genomics Applications (CEGA); Centre Ocean Sciences Centre (OSC), Memorial University of Newfoundland (MUN)						

Figure 11-11 Box cores recovered at a) DFO-3, b) DFO-5, c) DFO-7, d) DFO-8.

Figure 11-12 Individual of Ophiuroidea sp. 1 sampled at DFO-8.

11.2.7 *Agassiz Trawl*

Agassiz trawls were used as a complimentary method to cameras/ROVs and box corers to characterize benthic fauna. Deployments were limited to depths of less than 1000 m and over soft bottoms. Of the three stations that were less than 1000 m, none were deemed appropriate for Agassiz trawling. An opportunistically sampled site (DFO-750) did have a suitable bottom and the trawl was deployed for 15 minutes on July 31, 2018. Forty-four taxa and 1.26 kg of material were recovered from the trawl including various species of sponges, corals, fish, worms, crabs and copepods (Table 12.7, Figure 12.13).

Figure 11-13 Catch from Agassiz trawl conducted at DFO-750, July 31, 2018.

Table 12-7 Community assemblage sampled at DFO-750 (750 m; July 31, 2018) with Agassiz trawl.

Species	Identified onboard	
	# individuals	Biomass (g)
Sponge sp. 1	pieces	64
Asconema sp.	n.d.	219
Mycale mycale lingua	n.d.	52
Polymastidae	n.d.	23
Sponge sp. 2	pieces	57
Sponge sp. 3	pieces	23
Primnoa resedaeformis (dead)		<1
Lycopodina c.f. lycopodium	6	<1

Lithodes maja	1	47
Actinostella sp.	1	307
Halipteris finmarchia	1	<1
Boreonymphon sp.	10	<1
Pycnogonida sp. 2	6	<1
Pycnogonida sp. 3	4	<1
Paragorgia arborea	1 piece	<1
Lantern fish	6	23
Anthomastus agaricus?	15	5
Ophiocantha sp.	3	6
Heliometra glacialis	1	18
?Leptychaster arcticus	2	6
Zoanthid sp.	1	<1
Duva florida	2	17
Arrow worms	11	1
Skate egg case (empty)	1	3
Hydroid	n.d.	40
Paramuricea sp.	fragments	80
Colus sp. 1	1	<1
Buccinum sp.	2	8
Polychaete sp. 1	6	6
Colus sp. 2	1	<1
Astarte sp.	3	4
Hymendora glacialis	1.5	12
Boremysis sp.	27	11
Epimeria loricata	2	<1
Clavularidae	1	<1
Ophioruroidea sp.	104	12
Henricia sp.	2	<1
Bryzoans	pieces	4
Porifera	n.d.	96
Sponge sp. 5	3	<1
Copepoda	3	<1
N. abysorum	1	<1
Hydrozoa	n.d.	119
Isopoda	n.d.	<1
Total		1263

11.2.8 *Pelagic Fish and Plankton*

The mesopelagic fish and mesozooplankton community of the northern Labrador Sea is poorly described. Forming dense mid-water aggregations across the global oceans known as deep sound scattering layers (DSLs), mesopelagic organisms are hypothesized to be responsible for

the largest biomass aggregations of animal life on the planet and are crucial to the energy flow of the deep ocean (Proud et al 2017). In the Labrador Sea, myctophids (lanternfishes) and invertebrate zooplanktivores feed predominantly on calanoid copepods, but their effect on primary and secondary surface grazing zooplankton mortality is still unclear. While some studies attribute most of the biomass in the DSL to myctophids, the true diversity and abundance of taxa as well as foraging behavior in this region is poorly described. In the deep-water basins of the North Atlantic, seasonal differences in the diurnal vertical migration of these organisms has been observed (Anderson et al 2005). In the Arctic, the diel behavior of mesopelagic organism was associated with scattering layers originating from the Atlantic water mass (Gjøsæter et al 2017). Furthermore, differential diurnal vertical migration behavior among and within taxa in the mesopelagic zone has been observed and may be attributed to different adaptations to light conditions (Knutsen et al 2017). As an example, due to low metabolic demand of myctophids, only a portion of the population may be feeding at once, and stomach content analysis revealed some fish were feeding only every other day (Pepin 2013). On the other hand, other pelagic fish, such as Arctic cod, display vertical segregation and feeding strategies based on age and size class. In this study component, we aim to describe the behavior, spatial variation, and biodiversity of mesopelagic fishes and macroinvertebrates of the Labrador Sea.

Our understanding of the biodiversity of midwater scattering may be biased by traditional net sampling techniques which introduce selectivity bias. In many cases, gelatinous zooplankton and fast-swimming mesoplankton avoid capture and thus may be underestimated. Therefore, in this study we combine high resolution acoustic imaging (Wideband Autonomous Transceiver - WBAT), zooplankton imaging (Underwater Visioning Profiler - UVP5) with traditional midwater (Isaac-Kidd Midwater Trawl –IKMT), depth-stratified plankton net sampling (Hydrobios plankton net), and eDNA (described above) to better understand the biodiversity and forage dynamics of the DSL in the Labrador Sea. By closing this knowledge gap, we can elucidate surface to deep ocean pelagic food webs along the continental slope and their relationships to changing oceanographic conditions in the North Atlantic.

Deployments of these complimentary methods were co-located at all ISECOLD stations, except when gear issues limited the deployment of the IKMT (Table 11.8). Methods for each sampling approach are described below.

Table 12-8 Pelagic sampling activities related to the ISECOLD project.

Station	Sampling date	Hydrobios	IKMT	eDNA	WBAT	UVP 5
DFO-1	29-juil-18	●		●	●	●
DFO-3	30-juil-18	●	●	●	●	●
DFO-750	31-juil-18	●	●	●	●	●
DFO-5	2-Aug-18	●	●	●	●	●
DFO-7	2-Aug-18	●	●	●	●	●
DFO-8	3-Aug-18	●	●	●	●	●

DFO-11	4-Aug-18	●		●	●	●
DFO-9	4-Aug-18	●	●	●	●	●

11.2.9 *Wideband Autonomous Transceiver (WBAT)*

In complement to the traditionally used hull-mounted EK60 scientific echosounder, the broadband echosounder, an autonomous EK80 platform, offers a wide bandwidth frequency measurement of acoustic backscatter. While the hull-mounted EK60 operates at three discrete frequencies (38-, 120-, and 200- kHz), the WBAT measures backscatter at the 34-45 kHz range using a split-beam transducer, which allows for resolution and measurement of single targets. It also measures backscatter at the 283-383 kHz range using a single beam transducer. In combination, both wideband transducers provide frequency response curves and a high digitization rate for imaging midwater targets and aggregations of fish and zooplankton at deployed depths.

The WBAT was mounted in a 4’ x 1’ x 1’ steel mooring cage and transducers were mounted to steel plate on the underside. The entire package was hung vertically with transducers facing downward in the water (Figures 15,16). 1200-1500 broadband chirps were transmitted at each station with a 2s sampling interval to allow for phasing between 38 and 333 kHz transducers. Transducers were operated at 1.024 ms pulse lengths with 450 and 50 W power settings and data was recorded to 300m distance from the transducer.

Figure 11-14 The Wideband Autonomous Tranceiver deployment in Baffin Bay.

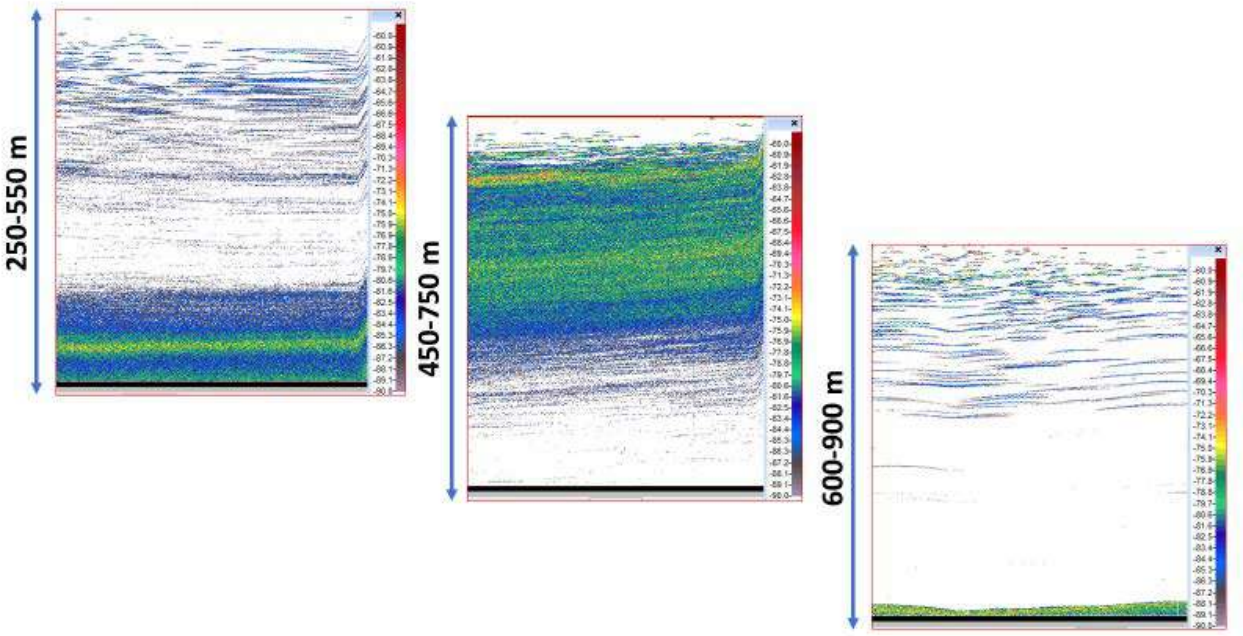

Figure 11-15 Integrated backscatter (Sv) of the water column at discrete sampling depths of the WBAT at station DFO-8.

At each sampling station in the Labrador Sea, the WBAT was deployed to four discrete depths. First, the WBAT was deployed within 20m of the surface to collect data on the epipelagic layer and establish a baseline for change across the surface of the transect. Then, it was deployed to a depth between 100-200m, where it images a portion of the water not typically associated with high biomass. Finally, the WBAT was deployed lowered to a depth determined by viewing the live backscatter on the EK60. This portion of the water column typically contains strong scattering organisms, and is hypothesized to contain the bulk of the mesopelagic fish and zooplankton community. Due to differences in the vertical segregation across spatial and diurnal scales, distinct operational depths were decided at each station.

11.2.10 *Uunderwater Vision Profiler 5 (UVP5)*

The UVP5 is an imaging platform that captures images of both living and non-living particles in the water column (Figure 17). It can provide a wide range of measurements including particulate size, number, and density. The platform is integrated with an image classification program known as Ecotaxa. Using a machine learning image classification algorithm, it can identify individuals by taxa, such as copepoda and metazoa, and in some cases down to the species level.

At each rosette sampling station, as the rosette was lowered to its rinsing depth, the pressure sensor on the UVP5 initiates an image capture sequence. The UVP5 continuously captures images as particles moved through its light field on the downcast. A live-read out of particulate density is displayed on the rosette control screen, plotted alongside other variables such as temperature and salinity. Data was captured and download with each rosette cast. Metadata

was entered at the end of each day into the zooprocess program and raw files were processed for future input into Ecotaxa.

Data will be sent to an experienced Ecotaxa user and reviewed for misclassification. A portion of the data will be used to train future classification models. All post-processing will be conducted by Marc Picheral, at IFREMR Villefranche. Classified data will be delivered to Julek Chawarski for further vertical and spatial analysis.

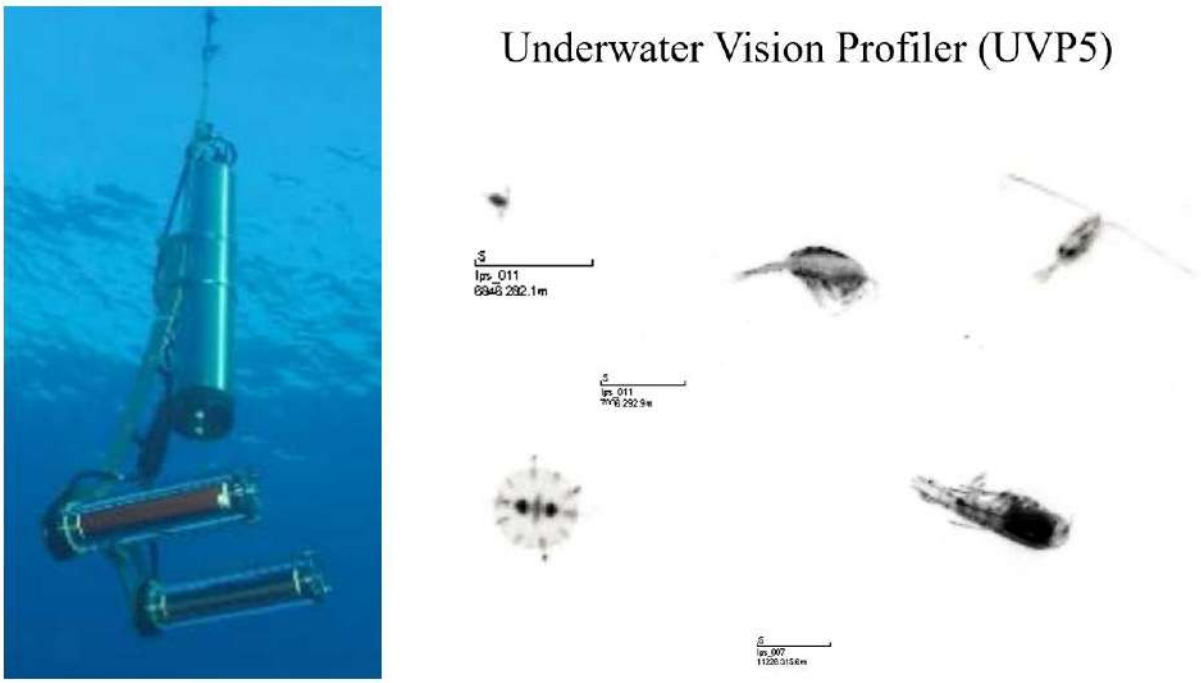

Figure 11-16 Examples of UVP5 images, processed using Zooprocess software and ready for image classification in Ecotaxa.

11.2.11 *Multi-net Plankton Sampler (Hydrobios)*

Plankton community characterization was done at various depth zones with a Hydrobios multi-net plankton sampler. The net is equipped with nine 200µm mesh nets (opening 0.5m^2) allowing for depth specific sampling of the water column (Figure 11.18). The Hydrobios is also equipped with a CTD to record water column properties while collecting biological samples.

The net is deployed vertically from 15m off the bottom to the surface. The nets open and close one by one as the pressure decreases while the net is going up in the water column. The depth at which the different nets open and close is programmed before deployment. Once retrieved, the zooplankton samples (Figure 11.19) were preserved in 10% formalin solution and stored for further taxonomic identification at Laval University.

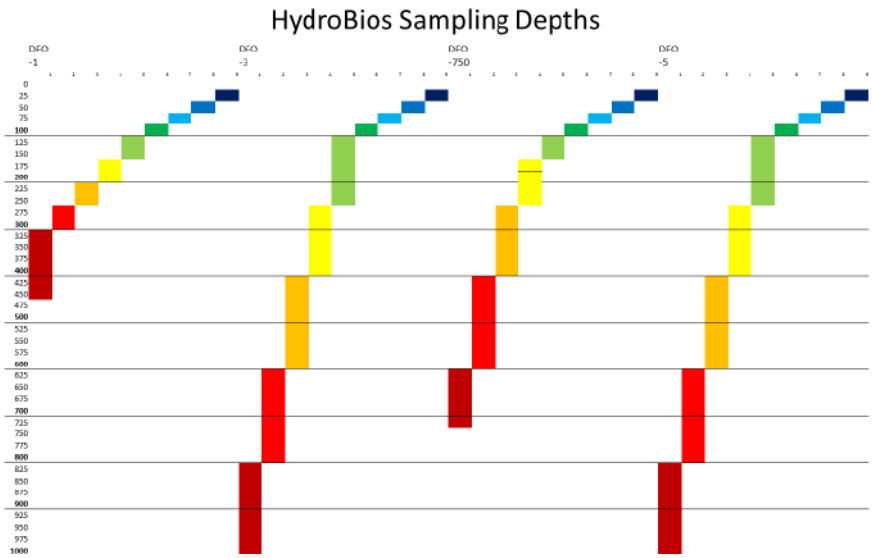

Figure 11-17 An example of the sampling depths of each of the Hyrdobios bottles, denoted by individual colors.

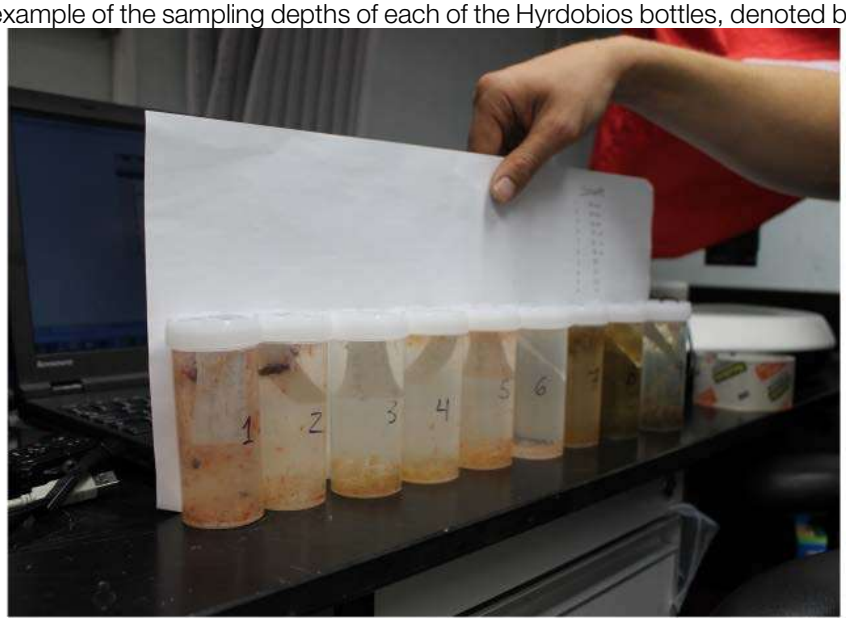

Figure 11-18 An example of the depth-specific samples collected by the Hydrobios net, with vial 1 containing the deepest samples and vial 9 containing the shallowest samples.

11.2.12 *Isaac-Kidd Midwater Trawl (IKMT)*

The IKMT (Figure 11.19) was deployed to capture pelagic juvenile and adult fish and microzooplankton. The net is rectangular in shape with a 9m^2 mouth aperture and mesh size of 11 mm in the first section, 5 mm in the last section. The net was lowered at a target depth which was determined by the echosounder EK-60 signal and towed at that depth for 20 minutes at a speed between 2.5 -3.2 knots. Collections were sorted in the laboratory by species, counted and weighed. In total 15 fish taxa and 17 invertebrate taxa were identified upon preliminary inspection of the samples (Table 11.9). Lanternfish were the dominant fish species in the catch

whereas Euphasiids and Gammarid Amphipods were the dominant invertebrate species (Figure 11.20).

Table 12-9 Preliminary results for species captured by the IKMT.

Mesopelagic fishes		Mesozooplankton					
Scientific name	Common Name	Euphausiids			Gamarid Amphipods		
Benthosema glaciale	Glacial Lanternfish	*Thysanoessa raschii*			*Themisto libellula*		
Lampanyctuc crocodilus	Jewel Lanternfish	*Meganyctiphanes norvegica*			*Themisto abysorum*		
Notoscopelus kroyeri	Northern Saillamp	*Thysanoessa longicaudata*					
Bathylagus euryops	Pencilsmelt				Chaetognatha		
Cyclothone microdon	Veiled Anglemouth	Gastropods			*Psuedosagitta maxima*		
Arctozenus risso	White barracudina	*Clione limacina*					
Stomia boa	Boa Dragonfish	*Limacina helicina*			Medusae		
Chauliodus sloani	Snipe Eel				Periphylla periphylla		
Nemichthys scolopaceus	Manylight viperfish	Decapods			Plus two others unidentified		
Macrouridae sp.	Grenadier (larval)	*Acantephyra pelagica*					
Liparis sp.	Snailfish	*Gnathophausia zoea*			Megantoptera		
Reinhardtius hippoglossoides	Greenland Halibut (larval)	*Hymendora glacialis*			2 unidentified species		
plus three other unidentified							

Figure 11-19 IKMT being deployed off the Amundsen, Leg 2C, 2018.

Figure 11-20 IKMT catch including lanternfish and several invertebrate species from DFO-.

11.2.13 *Seabird and Marine Mammal Surveys*

Seabird surveys were conducted using a standardized fixed-width survey area over a 90^0 scanning arc as per the Environment Canada Seabirds at Sea (ECSAS) protocols (Gjerdrum et al. 2012). These protocols were developed in a manner that is compatible with methods used by north Atlantic European countries. Surveys are conducted by the by the Canadian Wildlife Service (CWS), Department of Environment and Conservation Canada to address management and conservation responsibilities under the Migratory Bird Convention Act (MBC Act 1996). The Canadian Wildlife Service places seabird observers on multiple ships of opportunity throughout the year. Data are consolidated, summarized and analyzed from a central database maintained by the Atlantic Region office in Dartmouth, Nova Scotia. The data are open and shared with other departments and jurisdictions.

These data provide important information on pelagic seabird distribution throughout the year, including patterns of dispersal from breeding areas, migration routes and wintering areas. Over time, these data show not only patterns of dispersal, but also trends in species abundance, diversity and distribution. This information will therefore help inform decisions regarding protecting sensitive marine areas, environmental assessment of proposed development projects and appropriate response to catastrophic events (e.g. oil spills).

Seabirds are an integral part of marine ecosystems; their distribution is influenced by biological, chemical and physical oceanography. Changes in seabird distribution can therefore be an indicator of oceanographic variability. It is critically important to monitor seabird abundance and distribution patterns in the Arctic, in order to monitor changes that are happening in response to the rapid environmental changes induced by global warming. Collecting data in the remote regions of the Arctic is extremely expensive and all opportunities

to fill data gaps are very important. Seabird data collected since 1980 show population trends for significant seabird colonies in the Canadian Arctic (Gaston et al. 2009), including Thick-billed Murres and Northern Fulmars. Thick-billed Murre populations are apparently stable, but this species relies heavily on the sea ice-dependent Arctic Cod during the breeding season. Changes in sea ice and therefore prey availability may become a serious issue for this species in the future, potentially effecting population size and distribution throughout the eastern North Atlantic. Northern Fulmars have been in steady decline over the last decade. Data on breeding colonies and at-sea distribution is required to understand this decline.

The authors also report an 80% population decline in Ivory Gull numbers in the Nunavut region since 1980. It is currently listed as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and protected under the Species at Risk Act (SAR Act 2002). An ice scavenger, this species is very dependent on sea ice availability.

One thousand one hundred and sixty-five 5-minute survey watches were conducted during the expedition, representing ninety seven survey hours. A complete list of species observed is given in Table 11.10. Summary statistics and distribution maps will be provided by CWS in a timely manner upon return.

11.3 Preliminary Results

11.3.1 *Marine Mammals*

Marine Mammal surveys are conducted using protocols involving multiple observers, covering a 180^0 arc at an infinite distance. There was neither the manpower nor expertise onboard to fulfill these requirements. However, marine mammal data were collected opportunistically; primarily during seabird survey efforts. Marine mammal observations made outside of seabird surveys were added to the database as “incidental observations”. All marine mammals seen by the seabird observer or other persons on the bridge were recorded in the ECSAS database. Species identity was confirmed by the seabird observer prior to data entry. Coverage was incomplete and likely underestimates marine mammal species composition and abundance. A far more complete picture of marine mammal temporal abundance will be provided by the acoustic data (see Long Term Deployments of Environmental Sensors section). It should be noted that in the Labrador Sea along the Greenland continental shelf there was a large concentration of cetaceans, including over 20 large baleen whales and 20 Long-finned Pilot whales. At least some of these appeared to be associated with an ocean front. All species observed are listed in Table 11.10.

Table 12-10 Seabird and Marine Mammal Species List: Amundsen 2c Expedition, July 24-Aug 16 2018.

Species

Seabird		Marine Mammal	
Common Name	Scientific Name	Common Name	Scientific Name
Common Eider	*Somataria mollisima*	Cetaceans	
Northern Fulmar	*Fulmarus glacialis*	Fin Whale	*Balaenoptera borealis*
Great Shearwater	*Puffinus gravis*	Sei Whale	*Balaenoptera physalus*
Ivory Gull	*Pagophila eburnea*	Long-finned Pilot Whale	*Globicephala melas*
Sabine's Gull	*Xema sabini*	Harbour Porpoise	*Phocoena phocoena*
Black-legged Kittiwake	*Rissa tridactyla*	Narwhale	*Monodon monoceros*
Lesser Black-backed Gull	*Larus fuscus*	Seals	
Great Black-backed Gull	*Larus marinus*	Harp Seal	*Pagophilus groenlandicus*
Herring Gull	*Larus argentatus*	Hooded Seal	*Csystophora cristata*
Iceland Gull	*Larus glaucoides*	Ringed Seal	*Pusa hispida*
Glaucous Gull	*Larus hyperboreus*		
Red Phalarope	*Phalaropus fulicaria*	Polar Bear	*Ursus marinus*
Red-necked Phalarope	*Pagophila lobatus*		
Arctic Tern	*Sterna paradisaea*		
Pomarine Jaeger	*Stercoracarius pomarinus*		
Parasitic Jaeger	*Stercoracarius parasiticus*		
Long-tailed Jaeger	*Stercoracarius longicaudus*		
Thick-billed Murre	*Uria lomvia*		
Black Guillemot	*Cepphus grylle*		
Dovekie	*Alle alle*		

11.4 Reference

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12 Phytoplankton Biomass and Size Structure – Leg 3

Project leaders: Michel Gosselin[1] (michel_gosselin@uqar.ca) and Michel Poulin[2]
Cruise participant – Leg 3: Aude Boivin-Rioux[1]
[1] *Institut des sciences de la mer, Université du Québec à Rimouski, Rimouski, QC, Canada*
[2] *Musée canadien de la nature, Ottawa, ON, Canada*

12.1 Introduction

Primary producers play a central role in the oceans as they supply organic matter to the higher trophic levels, including zooplankton, fish larvae, marine mammals and birds. Marine polar ecosystems are particularly sensitive to any changes in phytoplankton dynamics due to their low number of trophic links (Grebmeier et al. 2006; Moline et al. 2008; Post et al. 2009). The Arctic Ocean is changing as evidenced by the decrease in sea ice thickness and extent (Stroeve et al. 2007; Kwok et al. 2009), the early melt and late freeze-up of sea ice (Markus et al. 2009) and the enhancement of the hydrological cycle (Peterson et al. 2006; Serreze et al. 2006). These environmental changes have already altered the phytoplankton biomass distribution in the Arctic Ocean (Arrigo et al. 2008; Pabi et al. 2008; Blais et al. 2017). In this context, the general objectives of our research project are (1) to determine the spatial and temporal variability in biomass, abundance and taxonomic composition of the phytoplankton communities, and (2) to determine the role of environmental factors on the phytoplankton dynamics and its variability in Baffin Bay and in the Canadian Arctic Archipelago.

The specific objectives of Leg 3 were to determine:

1) the downwelling incident irradiance, every 10 minutes, using a Li-COR 2 pi sensor
2) the transparency of the upper water column using a Secchi disk
3) the concentrations of dissolved organic carbon (DOC), total organic carbon (TOC), total dissolved nitrogen (TDN) and total nitrogen (TN) using a Shimadzu TOC-VCPN analyzer
4) the chlorophyll a and phaeopigment concentrations using a Turner Designs fluorometer (three size-classes: >0.7 µm, >5 µm, >20 µm)
5) the abundance and taxonomic composition of phytoplankton using the inverted microscopy method;
6) the abundance of pico- and nanophytoplankton, heterotrophic bacteria, heterotrophic dinoflagellates and viruses by flow cytometry.

12.2 Methodology

At each water column station, we collected water samples with 12 L Niskin-type bottles attached to a CTD-rosette. During the daytime and if weather permitted, we determined the depth of the euphotic zone using the Secchi disk. Size-fractionated (three size-classes: >0.7 µm, >5 µm and >20 µm) chlorophyll a concentrations were measured onboard the ship at each sampling depth using a Turner Designs fluorometer (model 10-AU). The other samples collected during this expedition will be analyzed at ISMER. Detailed sampling activities are summarized in Table 13.1.

Our chlorophyll a data will be used for the calibration of the CTD-Rosette chlorophyll a fluorescence sensor.

Table 14-1 Sampling operations during Leg 3 of the ArcticNet 2018 expedition on board the CCGS *Amundsen*.

Station	Cast	Date	Position (min)		Chlorophyll a			POC/PON	DOC/DN	HPLC	Taxo	Cyto
		(yy-mm-dd)	Lat (°N)	Long (°N)	>0.7µm	>5µm	>20µm		TOC/TN			flux
312	1	18-08-19	69°10.561	100°41.629	x	x	x	x	x	x	x	x
QMG1	3	18-08-20	68°29.407	099°53.122	x	x	x	x	x	x	x	x
QMG2	4	18-08-21	68°18.598	100°47.905	x	x	x	x	x	x	x	x
QMG4	5	18-08-22	68°28.734	103°25.974	x	x	x	x	x	x	x	x
QMG3	6	18-08-22	68°19.603	102°56.068	x	x	x	x	x	x	x	x
QMGM	7	18-08-22	68°17.950	101°44.503	x	x	x	x	x	x	x	x
322	8	18-08-26	74°29.934	080°33.355	x	x	x	x	x	x	x	x
101	9	18-08-27	76°22.918	077°23.729	x	x	x	x	x	x	x	x
Trinity (Near)	11	18-08-28	77°27.720	075°54.215	x	x	x	x	x	x	x	x
115	12	18-08-29	76°19.957	071°11.796	x	x	x	x	x	x	x	x
177	14	18-09-01	67°28.811	063°40.645	x	x	x	x	x	x	x	x

12.3 Preliminary Results

Chlorophyll a concentrations varied from about 10 to 95 mg m-2. Comparatively to other regions sampled, Lancaster Sound (station 322) had the highest averaged chlorophyll a concentration. Large cells (> 5µm) generally dominated the biomass throughout the study, with some exceptions in Baffin Bay (station 101) and in Qikiqtarjuaq (station 177) (Figure 14.1).

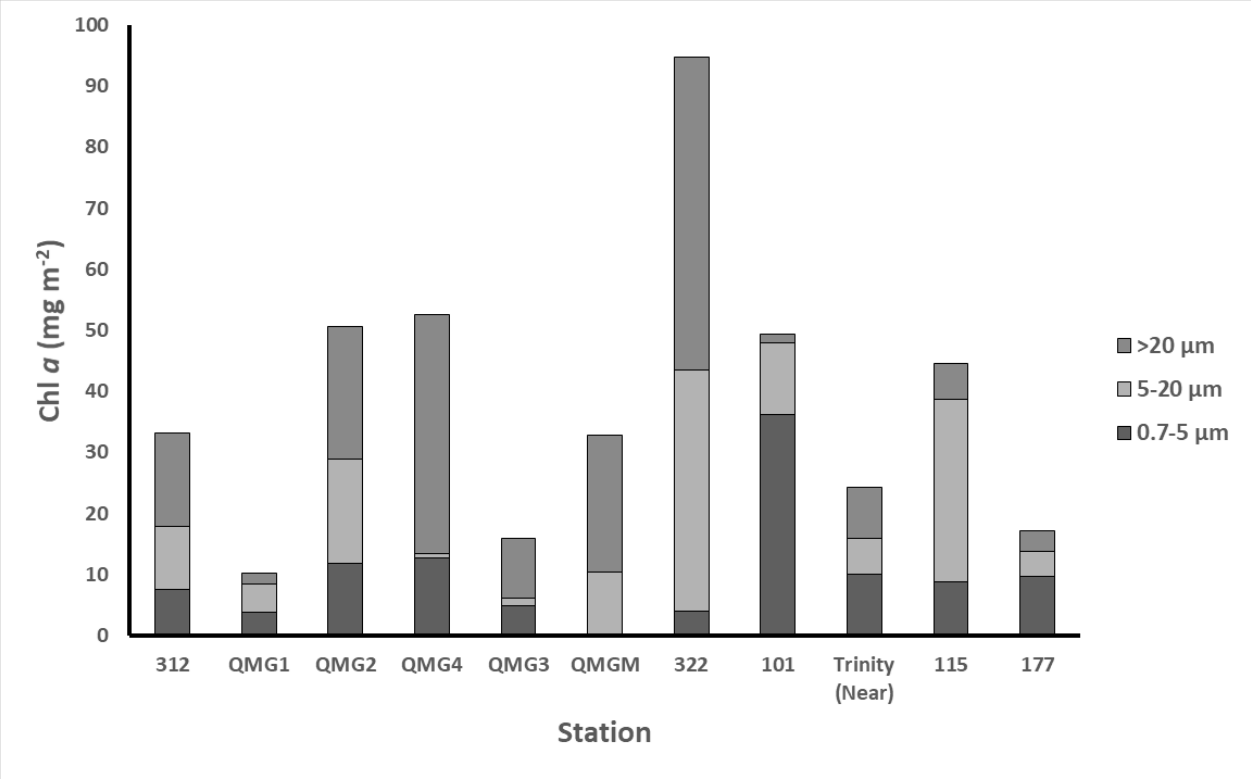

Figure 12-1 Chlorophyll a concentrations integrated over 100 m for different size fractions, 0.7-5 µm, 5-20 µm and > 20 µm, at stations sampled during Leg 3 of the ArcticNet 2018 expedition on board the CCGS *Amundsen*.

13 Development of a CSIA-AA based Proxy to Reconstruct Plankton Community Compositions in the Arctic Ocean– Leg 2c

Project leader: Owen Sherwood[1] (Owen.Sherwood @dal.ca)
Cruise participant – Leg 2c: Shaomin Chen[1]
[1] *Department of Earth Sciences, Dalhousie University, Halifax, NS, Canada*

13.1 Introduction

With the ongoing loss of Arctic sea ice, highly productive ice algae may vanish in the coming decades, which will alter the Arctic marine food web and impact primary productivity (Polyak et al., 2010; Overland & Wang, 2013). However, whether future ice-free conditions will increase or decrease the overall productivity remains unresolved (Sherwood et al., 2014; Arrigo & van Dijken, 2015; Tremblay et al., 2015). The application of CSIA-AA enables us to interpret carbon stable isotopic records preserved in sediments and deep-sea corals, which can reveal the nutrient-plankton dynamics over centennial timescales with annual-scale resolution (Schiff et al., 2014; Larsen et al., 2015). It has been found that different phylogenic groups of primary producers synthesize essential amino acid (EAA) with distinctive δ13CEAA signals, which are passed, unaltered, to the higher trophic levels (Larsen et al., 2009; Larsen et al., 2013). CSIA-AA can be applied to reconstruct plankton community composition and to examine the effect of climate change on marine ecosystems (McMahon et al., 2015). Inspired by the sea ice biomarker "IP25", which is a highly branched isoprenoid alkenone and has been used as an indicator for ice-living diatoms (Belt, 2008; Belt & Müller, 2013), We hypothesize that ice algae with physiological adaptations to extreme living conditions have distinctive δ13CEAA signals that can be fingerprinted and distinguished from other phylogenic groups. The new δ13CEAA proxy will allow us to quantify the proportional contributions of different plankton groups, including ice algae.

Therefore, our main objectives during the Amundsen 2018 expedition (Leg 2C) are to:

1) collect ice algae from sea ice to determine their δ13CEAA signals;
2) collect surface sediment from box cores to map the spatial distribution of δ13CEAA signals across the Northern Labrador Sea and Baffin Bay;
3) recover the sediment trap which was deployed at Saglek Bank in 2017 to determine the δ13CEAA signals over an annual cycle;
4) take push core samples from box cores and gravity cores for reconstruction of plankton compositions for longer time windows;
5) collect deep sea corals (Primnoa resedaeformis and Keratoisis ornata) to perform annually-resolved reconstruction of community composition;
6) collect water samples for NO3 isotope analysis to provide geochemical information of the coral-based records.

13.2 Methodology

13.2.1 *Core Sediment*

Surface sediment samples were taken from box cores at 5 stations (Table 14.1, Figure 14.1). Several spoonful of sediment was collected from the undisturbed surface of each box core with the help from Megan Hamp (University of Saskatchewan).

2 push cores and 1 gravity core were taken at Disko Fan with the help from Dr. Evan Edinger (Memorial University) and Fatma Dhifallah (Université du Québec à Rimouski).

13.2.2 *CTD-Rosette Sampling*

Water samples from CTD-Rosette casts were collected at 21 stations in the Frobisher Bay, Northern Labrador Sea and Baffin Bay (Table 14.2, Figure 14.1). Samples for NO_3 isotope analysis were taken and will be analyzed by Dr. Owen Sherwood at Dalhousie University. Apart from this, different variables were also sampled on behalf of other research groups. Dissolved carbon dioxide (pCO_2)/methane (CH_4) and dissolved inorganic carbon (DIC)/total alkalinity (TA) samples were taken for Dr. Kumiko Azetsu-Scott (Bedford Institute of Oceanography). Nutrients were sampled for Dr. Cara Manning (University of British Columbia) and will be sent to and analyzed by Dr. Jean-Éric Tremblay at Université Laval. Samples were taken with the help from Karl Purcell (Université du Québec à Montréal) and Robert Izett (University of British Columbia).

Table 15-1 Core sediment samples collected during the Amundsen 2018 (Leg 2C).

Station	Date	Latitude	Longitude	Depth	Core-top sediment	Push core	Gravity core
Saglek Deep	31/07/2018	60.46929	-61.09412	1162.29	•		
DFO-5	02/08/2018	60.46839	-60.5849	1424	•		
Sponge Site 2	02/08/2018	60.46692	-60.38003	1940.02	•		
Sponge Site 1	03/08/2018	60.46845	-59.25748	2415.08	•		
Disko Fan	10/08/2018	67.97867	-59.51255	910.6	•	•	•

Figure 13-1 Sampling from a box core (a, © Shaomin Chen) and from CTD-Rosette (b, © Karl Purcell).

Table 15-2 Water samples taken from CTD-Rosette during the Amundsen 2018 (Leg 2C).

Station ID	Date	Latitude	Longitude	Depth (m)	pCO_2/CH_4	DIC/TA	Nutrients	NO_3 isotope
9b	26/07/2018	62.67712	-66.48839	485.33	x	x	x	
Sponge Site 5	27/07/2018	60.40044	-62.90011	300.96			x	
Non-sponge Site 5	28	59.22465	-61.82626	150.68			x	
Non-sponge Site 4	28	59.31119	-61.01718	205.54			x	
Non-sponge Site 2	28	59.47487	-59.44245	1961			x	
Non-sponge Site 1	29	59.53374	-58.63407	2378.36			x	
Saglek Bank	29	60.45298	-61.25635	516.57	x	x	x	x
Sponge Site 4	30	60.45967	-62.12046	368			x	
Saglek Deep	31	60.4663	-61.10411	1138.11	x	x		
Sponge Site 2	02	60.46692	-60.38003	1940.02			x	
Sponge Site 1	03	60.46845	-59.25748	2415.08			x	
DFO-9	03	60.47102	-58.81319	2489.32	x	x	x	
DFO-11	04	60.44128	-57.09002	3026			x	
Hatton Basin	05	61.43727	-60.66732	612	x	x		
Lophelia	06	60.36968	-48.46247	700	x	x	x	x
NLSE07	09	63.2509	-54.1989	1175.29	x	x	x	x

SW Greenland-1	09	63.99804	-55.50314	1078.23			x	x
SW Greenland-2	10	66.49895	-57.00849	667.45			x	x
Disko Fan	10	67.97867	-59.51255	910.6	x	x	x	x
SW Greenland-3	11	68.97749	-62.48307	1892	x	x	x	x
Scott Inlet	12			~240	x	x	x	x

13.3 Reference

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14 Spatial Surveys of Net Community Production Rates and Phytoplankton Biomass and Taxonomy – Legs 2c and 3

Project leader: Philippe Tortell[1,2] (ptortell@eaos.ubc.ca)
Cruise participant – Leg 2c: Robert Izett[2]
Cruise participants – Leg 3: Cara Manning[2] and Zarah Zheng[2]
[1] *Peter Wall Institute of Advanced Studies, University of British Columbia, Vancouver, BC, Canada*
[2] *Department of Earth, Ocean, and Atmospheric Science, University of British Columbia, Vancouver, BC, Canada*

14.1 Introduction

Our involvement in the 2018 Amundsen Expedition centered on characterizing biological production rates (i.e. net community production), and phytoplankton biomass and taxonomic composition in surface waters. To achieve this, we deployed several autonomous instruments that measured water properties continuously from the ship's seawater supply line. The collection of these large, high-resolution datasets will enable us to relate in-situ measurements to properties observed via remote sensing. Thus, using the data collected on the Amundsen Expedition, we will calibrate and develop Arctic-specific satellite algorithms for primary productivity, and phytoplankton biomass and taxonomy.

Phytoplankton serve a foundational ecological role by forming the base of marine foodwebs and regulating the production of biomass at higher trophic levels. Net community production (NCP), biomass and taxonomic composition are useful metrics for quantifying the productivity, distribution and ecological role of phytoplankton in the ocean.

Net community production represents the balance between gross photosynthetic organic C-production and community-wide (i.e. autotrophic and heterotrophic) aerobic respiration. It is functionally equivalent to the rate of C-export from the upper ocean. Phytoplankton biomass can equally represent the baseline productivity of a region and is often associated with fish production. Meanwhile, the taxonomic composition of phytoplankton can be an indicator of the efficiency of carbon transfer through a foodweb or a predictor for the existence of higher trophic level species in a region. As global climate change and other anthropogenic perturbations continue to affect marine ecosystem function, the need to accurately quantify these metrics on ecologically-relevant space and time scales is becoming increasingly urgent.

As O_2 is involved in photosynthesis and respiration, NCP can be quantified from measurements of O_2. A common approach is to use the ratio of O_2-to-argon (Ar), where the deviation of the measured O_2/Ar ratio from the equilibrium ratio (i.e. $\Delta O_2/Ar$), is a tracer of biological production (Craig & Hayward, 1987). Ship-based mass spectrometry has been commonly employed to obtain continuous measurements of the seawater O_2/Ar ratio at sub-kilometer scales (e.g. Tortell, 2005). However, despite the high-resolution data afforded by this approach, ship-based mass spectrometers can be cost-prohibitive to many research groups, and require considerable

expertise and attention to maintain and run at sea. The development of stable O_2 sensors, and Gas Tension Devices (GTDs) with high-sampling frequencies provides impetus for the adoption of an alternative system for NCP estimation. Using measurements of total seawater gas tension (i.e. sum of all dissolved gases' partial pressures) from the GTD, concentrations of nitrogen (N_2), a gas with similar solubility properties to O_2 and Ar, can be derived. In this manner, the $\Delta O_2/N_2$ quantity is also a tracer of biological production in many cases. Thus, it is conceivable that the concurrent deployment of an optode and GTD can yield underway estimates of the seawater $\Delta O_2/N_2$ signature, from which NCP estimates can be calculated. To-date, few studies have compared MIMS-based $\Delta O_2/Ar$ and optode/GTD-based $\Delta O_2/N_2$ data side-by-side. The Amundsen Expedition provided an opportunity to compare these signatures over a broad and diverse range of oceanographic regimes.

Phytoplankton biomass is commonly approximated by the concentration of chlorophyll *a* (chl *a*) in seawater. Typically, measurements of chl *a* have been obtained from discrete samples, or via continuous measurements of seawater fluorescence by shipboard sensors. However, in vivo chl *a* fluorescence is often uncoupled from true chl *a* concentrations due to the variability of the strength of fluorescence under different ambient light conditions (i.e. nonphotochemical quenching). The recent development of autonomous sensors capable of making high-resolution measurements of hyperspectral (i.e. at multiple wavelengths) seawater absorption signatures has increased the potential for obtaining continuous measurements of phytoplankton biomass. This approach relies on the strong relationship between chl *a* concentrations and particulate absorption line height at 676 nm (Davis et al., 1997).

High-resolution, underway datasets are useful for observing fine-scale features in ocean surface conditions, and for mapping the distribution of seawater properties over a range of ocean regions and regimes. These datasets can also be related to variability in observations of ocean biogeochemistry, and marine ecosystem function. Ultimately, empirical relationships can be derived to relate marine NCP, phytoplankton biomass or taxonomy to properties which can be observed via remote sensing. Thus, regional (i.e. Arctic-specific) satellite algorithms can be developed, or fine-tuned using high-resolution, in-situ data, so that near-daily coverage of entire ocean regions can be obtained. Subsequently, the relationships between phytoplankton productivity and a variety of marine ecosystem process can be explored. One such avenue is in characterizing the relationship between productivity at the base of the foodweb with the distribution of commercially, culturally, and ecologically important fish, mammal and bird species.

Our main objectives during the Amundsen 2018 Expedition were to:

1) finely characterize the spatial distribution of NCP and phytoplankton biomass in surface waters of the Expedition survey area using autonomous seawater sensors;
2) evaluate the performance of a new instrument platform that is capable of autonomous ship-based surveys for NCP measurements;
3) validate an algorithm predicting phytoplankton functional groups and size classes from total chl *a* concentration.

The data collected during the Expedition will ultimately be used to calibrate and ground-truth regional satellite algorithms for NCP, chl *a* and phytoplankton taxonomy. This work will be continued on Leg 3 of the 2018 Expedition.

Discrete samples for nitrous oxide (N_2O), methane (CH_4), N_2O Isotope, and nitrate isotope distributions were also collected on behalf of Dr. Cara Manning (UBC; Dept. of Earth, Ocean and Atmospheric Science). Water column profiles were obtained from the Rosette (stations DFO9, Lophelia, NLSE07, SW Greenland-3, SW Greenland-4, and Scott Inlet). Within the Lancaster Sound region, we also targeted some rivers for gas sampling. Unfortunately, heavy fog prohibited the use of the Amundsen's helicopter, so this work could not be completed. Discrete gas sampling, from Rosettes and rivers, will be continued on Leg 3 of the Expedition, and will be described in that leg's report.

14.2 Methodology

We deployed several sensors in the Amundsen's Forward Filtration laboratory (Figure 15.1) for obtaining autonomous measurements of surface gas (O_2, Ar, and N_2), and chl *a* concentrations. Water was pumped continuously from the ocean surface into the laboratory, and through the respective instruments. Specifically, a membrane inlet mass spectrometer (MIMS) was used to obtain measurements of the seawater O_2/Ar ratio. Parallel to the MIMS, an *Aanderaa* optode, and *ProOceanus* GTD measured O_2 concentrations and total dissolved gas tension, respectively. Using these instruments, the seawater O_2/N_2 ratio was derived. In addition, a *WetLabs* AC-s measured seawater absorption and attenuation spectra across a range of 400 to 700 nm. All sensors produced measurements at less than one-minute intervals.

To calibrate the optode (O_2 sensor) we obtained periodic discrete samples for O_2 analysis. Samples were collected from the seawater sink in the laboratory, and from the ocean's surface via Rosette sampling. Discrete O_2 samples were analyzed onboard by Winkler titration. We observed a consistent offset between optode-derived and discrete O_2 samples (Figure 15.2, Figure 15.3). This offset was applied to the underway data to calibrate for instrument drift (Figure 15.2, Figure 15.3).

Discrete samples for total and size-fractionated chl *a* concentration and HPLC (i.e. phytoplankton pigment analysis, from which taxonomic composition can be estimated) were also obtained by filtering water collected from the continuous seawater supply pump. Samples were filtered onto 0.2 µm, 2.0 µm, and 20 µm pore-size filters for chl *a* size class analysis, and on 47 mm GF/F filters for HPLC. After collection, the filters were stored in the -80 °C freezer, until analysis after the Expedition. Using these data, an algorithm relating total chl *a* content to phytoplankton size and functional groups can be defined so that phytoplankton taxonomy can be estimated via remotely sensed sea surface chl *a* concentrations.

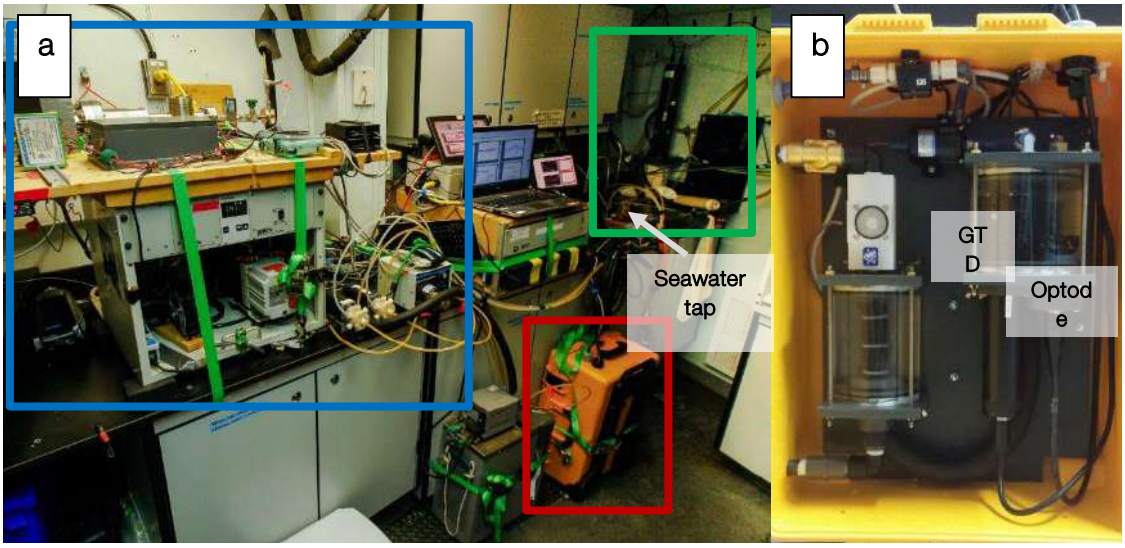

Figure 14-1 Forward filtration laboratory (a) with the MIMS (blue box), optode/GTD (red) and AC-s (green) systems. The optode/GTD system is shown in (b). Seawater was pumped from the ocean surface and distributed to the instruments via a seawater tap.

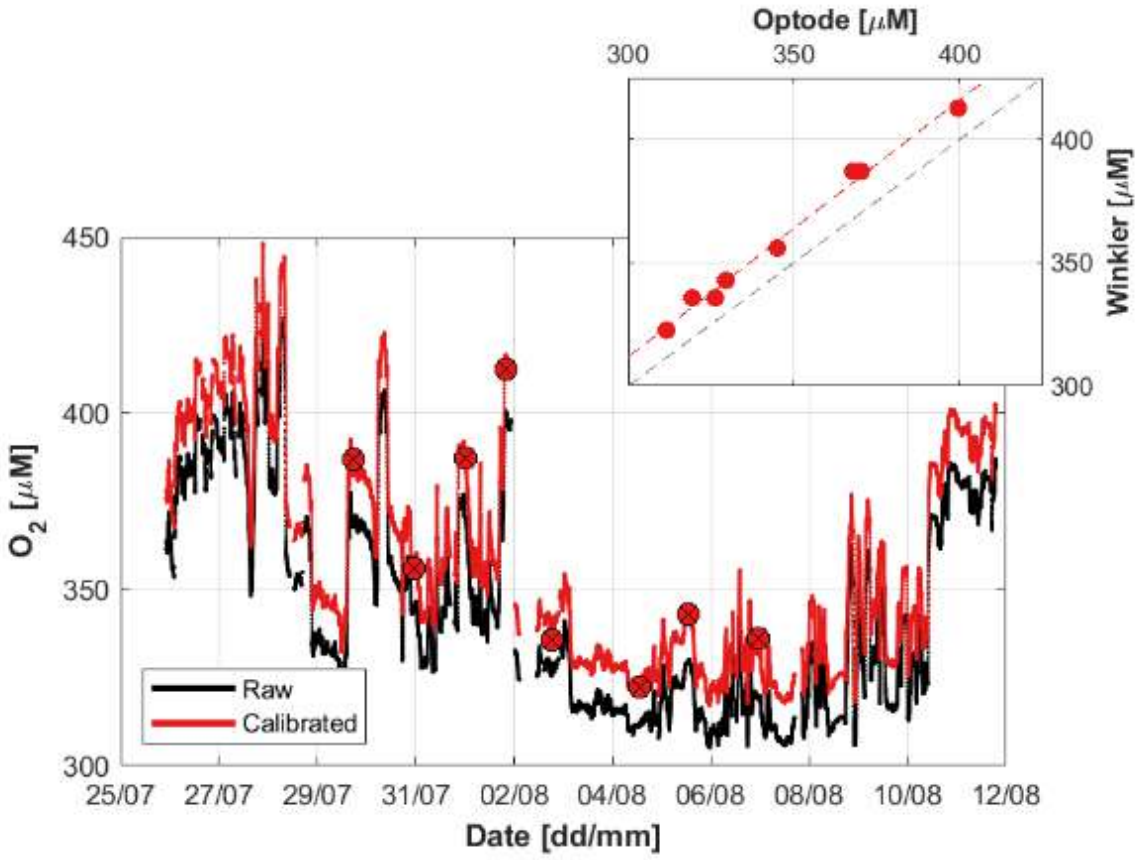

Figure 14-2 (Leg 2c): (a)There was a consistent linear offset between O2 concentrations derived from the optode and corresponding concentrations derived through discrete Winkler analysis. (b) The offset was applied to underway optode data to derive calibrated measurements. The “cross” markers in (b) represent the discrete samples.

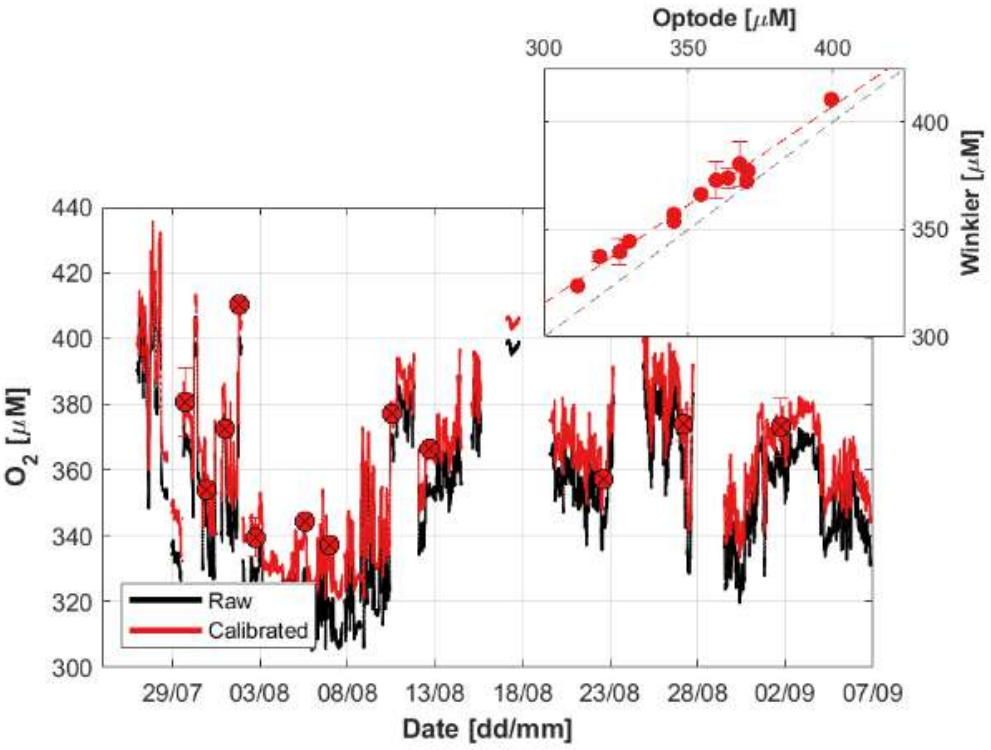

Figure 14-3 (Leg 3): (a)There was a consistent linear offset between O_2 concentrations derived from the optode and corresponding concentrations derived through discrete Winkler analysis. (b) The offset was applied to underway optode data to derive calibrated measurements. The "cross" markers in (b) represent the discrete samples.

14.3 Preliminary Results

After troubleshooting some issues with the seawater supply pump (merci to Thomas), we began collecting continuous underway data in lower Frobisher Bay and Labrador Sea. We subsequently obtained a near-continuous dataset for the duration of the leg (Figure 15.4). Preliminary results from our underway gas sensors (MIMS and optode/GTD) suggest reasonable coherence between $\Delta O_2/Ar$ and $\Delta O_2/N_2$ measurements across most of the Expedition range (Figure 15.5).

Differences between $\Delta O_2/Ar$ and $\Delta O_2/N_2$ are expected under some conditions, and may be explained by wind speed history, sea surface temperature history, and/or nitrogen fixation in the days prior to sampling from the ship. For example, because N_2 has a lower solubility than Ar, elevated wind speeds resulting in bubble entrainment and dissolution during whitecap formation and wave collapse would cause an increase in the N_2 saturation state relative to that of Ar (Hamme & Emerson, 2006). Thus, recent periods of high wind speeds are likely responsible for $\Delta O_2/N_2$ signals that are lower than $\Delta O_2/Ar$. Conversely, N_2-fixation by has been observed in the N. Atlantic and Arctic. This could serve to lower N_2 concentrations relative to O_2, thereby causing $\Delta O_2/N_2$ signals that are higher than $\Delta O_2/Ar$. Further analysis will be required to identify exact conditions in which the two signals differ, and to determine if it is possible to empirically predict

when they diverge. Ultimately, the early results from this Expedition are promising for the future deployment of an optode/GTD system for replacing MIMS in deriving estimates of NCP. Moving forward, we will continue to test the system on subsequent Expeditions and in other ocean regions (e.g. N. Pacific).

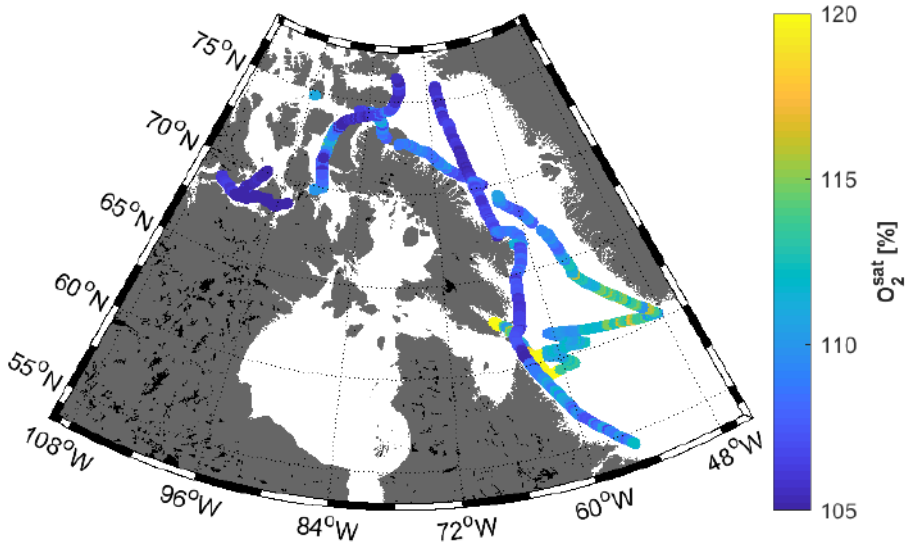

Figure 14-4 Underway measurements of the O_2 saturation state (% of equilibrium) derived from the optode/GTD system. Measurements were obtained at a sampling resolution of approximately 20-sec. Data from legs 2c (Iqaluit to Resolute Bay) and 3 (Resolute Bay to Quebec City).

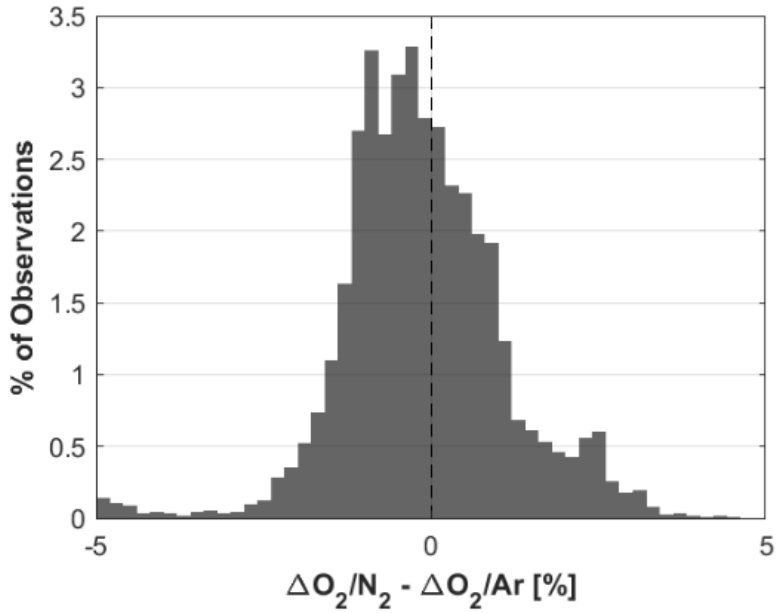

Figure 14-5 The differences between ΔO2/Ar and ΔO2/N2 across the legs 2c and 3 Expedition region. Data were binned into 10-min intervals to minimize signals attributed to differences in instrument response times.

The underway absorption and attenuation data cannot be processed on board, while the discrete chl a and HPLC samples will be analyzed in a laboratory on land. However, data from the AC-s appeared to be high-quality, and we experienced no major instrument issues. The clogging of the seawater pump also affected the coverage of these data.

14.4 Reference

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15 Marine Productivity: Carbon and Nutrients Fluxes – Legs 1, 2 and 3

Project leader: Jean-Éric Tremblay[1] (Jean-Eric.Tremblay@bio.ulaval.ca)
Cruise participant - Leg 1: Jonathan Gagnon[1], Janghan Lee[1] and Kasey Cameron-Bergeron[1]
Cruise participant - Leg 2a: Jean-Éric Tremblay[1], Gabrièle Deslongchamps[1], Gabrielle Fortin[1], Kasey Cameron-Bergeron[1], Janghan Lee[1], Vincent Marmillot[1]
Cruise participant Leg - 3: Gabrièle Deslongchamps[1] and Vincent Villeneuve[1]
[1] *Département de biologie, Université Laval, Québec, QC, Canada.*

15.1 Introduction

The Arctic climate displays high inter-annual variability and decadal oscillations that modulate growth conditions for marine primary producers. Much deeper perturbations recently became evident in conjunction with globally rising CO_2 levels and temperatures (IPCC 2007). Environmental changes already observed include a decline in the volume and extent of the sea-ice cover (Johannessen et al. 1999, Comiso et al. 2008), an advance in the melt period (Overpeck et al. 1997, Comiso 2006), and an increase in river discharge to the Arctic Ocean (Peterson et al. 2002, McClelland et al. 2006) due to increasing precipitation and terrestrial ice melt (Peterson et al. 2006). Consequently a longer ice-free season was observed in both Arctic (Laxon et al. 2003) and subarctic (Stabeno & Overland 2001) environments. These changes entail a longer growth season associated with a greater penetration of light into surface waters, which is expected to favoring phytoplankton production (Rysgaard et al. 1999), food web productivity and CO_2 drawdown by the ocean. However, phytoplankton productivity is likely to be limited by light but also by allochtonous nitrogen availability. The supply of allochtonous nitrogen is influenced by climate-driven processes, mainly the large-scale circulation, river discharge, upwelling and regional mixing processes. In the global change context, it appears crucial to improve the knowledge of the environmental processes (i.e. mainly light and nutrient availability) interacting to control phytoplankton productivity in the Canadian Arctic. Also, changes in fatty acid proportions and concentrations will reflect shifts in phytoplankton dynamics including species composition and size structure, and will reveal changes in marine energy pathways and ecosystem stability[123].

15.1.1 *Objectives Leg 1*

The main goals of our team were to establish the horizontal and vertical distributions of phytoplankton nutrients and to measure the primary production located at the surface of the water column using O_2/Ar ratios and tracers incubations. Auxiliary objective was to calibrate the ISUS nitrate probe attached to the Rosette.

15.1.2 *Objectives Leg 2a*

The main goals of our team for Leg 2a of ArcticNet 2018 were to establish the horizontal and vertical distributions of nutrients, to measure the primary production and nitrogen uptake in the water column and to assess the fatty acids concentrations in phytoplankton as well as

zooplankton. Auxiliary objective was to access the effects of acidification and temperature on lipids.

15.1.3 *Objectives Leg 3*

The main goals of our team for Leg 3 of ArcticNet 2018 were to establish the horizontal and vertical distributions of nutrients and to access the effect of temperature on primary production and nitrogen uptake using experimental conditions.

15.2 Methodology

15.2.1 *Leg 1*

Samples for inorganic nutrients (ammonium, nitrite, nitrate, orthophosphate and orthosilicic acid) were taken at all NUTRIENTS/BASIC/FULL stations (Table 18.1) to establish detailed vertical profiles. Samples were stored at 4°C in the dark and analyzed for nitrate, nitrite, orthophosphate and orthosilicic acid within a few hours on a Bran+Luebbe AutoAnalyzer 3 using standard colorimetric methods adapted for the analyzer (Grasshoff et al. 1999). Additional samples for ammonium determination were taken at stations where incubations were performed and processed immediately after collection using the fluorometric method of Holmes et al. (1999). A quadrupole mass spectrometer (PrismaPlus, Pfeiffer Vacuum) was used to measure the dissolved gases (N_2, O_2, CO_2, Ar) coming for the underway seawater line located in the 610 laboratory. O_2 to Ar ratios will later be analyzed to measure primary production that occured up to 10 days prior of the ship's passage in all the areas visited.

In order to examine the potential effects of environmental conditions (e.g. acidity, alkalinity, free $C0_2$) on energy transfer through food chain, we realized at Full and Basic stations, 3L filtration in duplicate from water surface and SCM with pre-combusted GF/C, to analyse the lipids composition, which is the densest form of energy, in particulate organic matter. Samples of 100 to 1000mg of earlier and adult stage of copepods were also realized and stored on GF/F filters by -80°C to aims our objectives. Moreover the pH of SCM and surface water has been measured by spectrophotometer by using red phenol and cresol purple colorants. Then we stored 500ml of water from each depth to determine the alkalinity in laboratory as soon as possible after the end of the mission. Finally we continue the long term analysis conducted during previous year such as filtration of POC/PN, POP, BSi and incubation of phytoplankton with 15N. To determine nitrate, ammonium and urea uptake rates and primary production, water samples from the surface were incubated with ^{15}N and ^{13}C tracers. The bottles were then incubated for 24 h using on deck incubator and light controlled incubators to establish the relation between photosynthesis and irradiance. After 24 h, the water samples were filtered through a pre-combusted GF/F filters and the filters dried for 24 h at 60°C for further analyses. Nutrients at T_0 were measured with the Auto-Analyzer. Incubations were then terminated by filtration through a pre-combusted GF/F filters and stored for further analyses. Isotopic ratios of nitrogen and carbon from all GF/F filters will further be analyzed using mass spectrometry.

Table 18-1 List of sampling stations and measurements during Leg 1

						Filtrations								Incubations			
Station	Cast	Nutrients	NH4	15N-NO3	Urea	Ab. Nat. POM	Total Sele.	POP	Bsi	PIC	POC PN	Lipids POM	Taxo	Upt. NH4	Upt. NO3	Upt. Urea	N2 Fix
1	1	X		X													
2	2	X		X													
3	3	X		X													
4	4	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
5	5	X		X													
6	6	X		X													
7	7	X		X													
8	8	X		X													
9	9	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
9	10	X		X													
10	11	X		X													
11	12	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
11	13	X		X													
12	14	X		X													
13	15	X		X													
15	17	X		X													
15	18	X		X													
16	19	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
16	20	X		X													
17	21	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
18	22	X		X													
18	23	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
19	24	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
19	25	X		X													
20	26	X		X													
21	27	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
21	28	X		X													
22	29	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
22	30	X															
23	31	X	X		X	X		X	X	X	X		X				
24	32	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
24	33	X		X													
25	34	X		X													
25	35	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
26	36	X		X													
27	37	X		X													
28	38	X	X		X	X		X	X	X	X		X				
29	39	X		X													
31	40	X		X													
32	41	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
32	42	X															
34	43	X	X		X	X		X	X	X	X		X	X	X	X	X
34	44	X		X													
35	45	X		X													
36	46	X		X													
36	47	X	X		X	X		X	X	X	X		X	X	X	X	X
37	48	X		X													
38	49	X	X		X	X		X	X	X	X		X	X	X	X	X
38	50	X		X													
39	51	X		X													
40	52	X	X		X	X		X	X	X	X		X	X	X	X	X
40	53	X		X													
41	54	X		X													
15B	55	X															
44	56	X	X		X	X		X	X	X	X		X	X	X	X	X
44	57	X		X													
45	58	X	X		X	X		X	X	X	X		X	X	X	X	X
45	59	X	X		X	X		X	X	X	X		X	X	X	X	X
W-T 01	60	X		X													
W-T 02	61	X		X													
W-T 03	62	X		X													
46	63	X	X		X	X		X	X	X	X		X	X	X	X	X
46	64	X		X													
9	ice	X	X			X	X	X	X	X	X	X	X				
H3	ice	X	X			X	X	X	X	X	X	X	X				
16	ice	X	X			X	X	X	X	X	X	X	X				
NE01	from the barge	X	X	X	X	X		X	X	X	X		X	X	X	X	X
NE02	from the barge	X	X	X	X (?)	X		X	X	X	X		X				
NE03	from the zodiac	X	X	X	X	X		X	X	X	X		X	X	X	X	X
NE04	from the zodiac	X	X	X	X	X		X	X	X	X		X	X	X	X	X
Wilson	from the helicopter	X	X	X	X	X		X	X	X	X		X	X	X	X	X
Ferguson	from the helicopter	X	X	X	X	X		X	X	X	X		X	X	X	X	X
Tha-Anne	from the helicopter	X	X	X	X	X		X	X	X	X		X	X	X	X	X
Thlewiaza	from the helicopter	X	X	X	X	X		X	X	X	X		X	X	X	X	X
Nelson	from the helicopter	X	X	X	X	X		X	X	X	X		X	X	X	X	X
Hayes	from the helicopter	X	X	X	X	X		X	X	X	X		X	X	X	X	X
Severn	from the helicopter	X	X	X	X	X		X	X	X	X		X	X	X	X	X
Winisk	from the helicopter	X	X	X	X	X		X	X	X	X		X	X	X	X	X
Seal	from the helicopter	X	X	X	X	X		X	X	X	X		X	X	X	X	X
Knife	from the helicopter	X	X	X	X	X		X	X	X	X		X	X	X	X	X
Churchill	from the helicopter	X	X	X	X	X		X	X	X	X		X	X	X	X	X
Churchill	Zodiac	X	X	X	X			X	X	X	X		X	X	X	X	

15.2.2 *Leg 2a and 3*

Samples for inorganic nutrients (ammonium, nitrite, nitrate, orthophosphate and orthosilicic acid) were taken at all stations (Table 17.2) to establish detailed vertical profiles. Samples were stored at 4°C in the dark and analyzed for nitrate, nitrite, orthophosphate and orthosilicic acid within a few hours on a Bran+Luebbe AutoAnalyzer 3 using standard colorimetric methods adapted for the analyzer (Grasshoff et al. 1999). Samples for ammonium determination where collected at all depths and processed immediately after collection using the fluorometric method of Holmes et al. (1999). To determine the effect of temperature on nitrate and ammonium uptake and primary production rates, water samples the scm were incubated with 15N and 13C tracers. The bottles were then incubated for 24 h using temperature and light controlled incubators. After 24 h, the water samples were filtered through a pre-combusted GF/F filters and the filters dried for 24 h at 60°C for further analyses. Incubations were then terminated by filtration through a pre-combusted GF/F filters and stored for further analyses. Isotopic ratios of nitrogen and carbon from all GF/F filters will further be analyzed using mass spectrometry.

A quadrupole mass spectrometer (PrismaPlus, Pfeiffer Vacuum) was used to measure the dissolved gases (N_2, O_2, CO_2, Ar) coming for the underway seawater line. O2 to Ar ratios will later be analyzed to measure primary production that occured up to 10 days prior of the ship's passage in all the areas visited.

Table 18-2 List of sampling stations and measurements during Leg 2a

	NO_3, NO_2, Si, PO_4, NH_4 (full profile)	NO_3 natural abundance (full profile)	POP, BSi, POC/PN, lipids phyto, C and Nnatural abundance, HPLC, taxo, total selenium (surface and scm)	^{15}N-tracers uptake experiments	Urea, chla (optical depths)	Lipids zoo (nets)
Station						
731	X	X	X	X	X	
730	X	X	X	X	X	
736	X	X	X	X	X	X
736Z	X	X	X	X	X	
689	X	X	X	X	X	
689Z	X	X	X	X	X	
341	X	X	X	X	X	X
River						
Puvurnituq	X	X	X	X	X	
Deception Bay	X	X	X	X	X	
Salluit	X	X	X	X	X	

Table 18-3 List of sampling stations and measurements during Leg 3

	NO3, NO2, Si, PO4	NH4	15N-tracers uptake experiments (SCM only)
Stations			
07-nov	●	●	
QMG1	●	●	
QMG2	●	●	
QMG3	●	●	
QMG4	●	●	
QMGM	●	●	
17-nov	●	●	●
10-avr	●	●	●
Trinity	●		
24-avr	●	●	●
25-juin	●	●	●
Rivers			
CMLF	●		●
CMSR2	●		●
CMER	●		●
CMTR	●		
CMCR	●		
CMGR	●		
CMSR	●		

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16 Microbial and Geochemical Baselines in Baffin Bay and the Labrador Sea - Leg 2c

Project leaders: Casey Hubert[1] (chubert@ucalgary.ca) and Gary Stern[34]
Cruise participants – Leg 2c: Anirban Chakraborty[1], Margaret Cramm[1], Aprami Jaggi[2] and Katarzyna Polcwiartek[3]
[1] *Department of Biological Sciences, University of Calgary, Calgary, AB, Canada*
[2] *Department of Geosciences, University of Calgary, Calgary, AB, Canada*
[3] *Centre for Earth Observation Science, University of Manitoba, Winnipeg, MB, Canada*
[4] *Fisheries and Oceans Canada, Winnipeg, MB, Canada*

16.1 Introduction

16.1.1 *Benthic Microbial Diversity and Hydrocarbon Baselines*

Marine sediment environments are high in microbial diversity and abundance with a cubic centimetre of seabed typically containing billions of microbial cells – about a thousand fold more than in overlying seawater. The intent of this research in Baffin Bay is to establish baseline data for microbial diversity and geochemistry in these regions, and experimentally investigate how short and long term changes in environmental parameters (e.g. temperature; pulses of organic compounds such as hydrocarbons) may affect the community composition, metabolic rates and cycling of carbon and other nutrients. This work will determine the impact of permanently cold temperatures on the rates of biogeochemical processes such as sulfate reduction, which is responsible for up to half of organic carbon mineralization in coastal sediments.

The occurrence and locations of marine hydrocarbon seeps in Canada's Arctic are important to assess the ability of microbiota in Arctic seawater and sediments to biodegrade accidentally released petroleum hydrocarbons. A rapid natural response may depend on a region's microbiota being 'primed' for such biodegradation by the slow natural release of hydrocarbons from seabed seeps. Sediment associated microbial communities will be compared to microbial communities in the water column to elucidate possible relationships of hydrocarbon degrading communities between the two environments. Samples collected will also be compared to Gulf of Mexico (GoM) sediment samples (a well-studied environment for bioremediation of spilled hydrocarbons) to measure any differences in the potential for biodegradation (microbial communities, rates of hydrocarbon oxidation).

The purpose of this study is to measure baseline microbial diversity and geochemistry in the Baffin Bay marine environment prior to future increases in marine traffic. This data will be used to help develop a predictive measure of how different regions of the Arctic could respond to various pollution scenarios.

16.1.2 *Sediment Sampling along a Hydrocarbon Seep Transect*

Oil reserves in the Canadian Arctic are currently being studied for future extraction by major oil companies; with reservoirs estimated to contain billions of barrels of oil. Receding ice coverage

as a result of climate change is making these oil reserves easily accessible, and increasing the feasibility of exploration of offshore oil in the region. The consequence of declining ice conditions will be an inevitable increase in oil exploration as well as shipping traffic through the Canadian Arctic. A higher frequency of these activities will increase the risk for oil-spills in the Arctic, potentially releasing an unprecedented volume of petroleum hydrocarbons in the Arctic marine environment. However, hydrocarbons also naturally occur in Arctic marine sediments through natural oil seeps, fossil fuel combustion, and terrestrial run-off.

Our work utilizes targeted diversity studies to explore the abundance and function of thermophilic endospores (thermospores) that remain dormant in permanently cold sediments, elaborating on biogeography analyses that have been conducted in the Eastern Arctic Ocean e.g. Svalbard. These spore-forming thermophiles belong to the so-called rare biosphere and are not detected in nucleic-acid-based diversity assays. Previous research has shown an unexpectedly high abundance of thermospores in sediments of the Eastern Arctic. Dormancy and unexpectedly high abundances make these thermospores ideal model organisms for studying passive dispersal. Additionally, the phylogenetic similarity between thermospores and microbes inhabiting oil reservoirs offers a clue about their possible origins. This study will test the hypothesis that thermospores are inhabitants of deeply buried hot oil reservoirs and are exposed to the cold seabed by deep-to-shallow passive dispersal through natural hydrocarbon seeps.

16.2 Methodology

16.2.1 *Benthic Microbial Diversity and Hydrocarbon Baselines*

During Leg 2c, sediment was collected using the box corer and water was collected using the CTD Rosette.

Surface Sediment Sampling

Samples collected (Table 19.1) for DNA extraction and cell enumeration (for microbial diversity analysis) were scraped from the top 1 cm of the box core using an ethanolsterilized metal spatula. These surface samples were stored in 2 mL cryovials (triplicate) and stored at -80°C. Surface sediment was dispensed by the method listed above into 2 mL cryovials and fixed with 4% formalin and stored at 4°C for cell preservation.

Table 19-1 Sediment and water samples collected during Leg 2C of ArcticNet 2018. Analyses on the samples include DNA analysis and cell counting (Microbiol.), dissolved organic material (DOM) and hydrocarbon analysis (HC).

Date	Station ID	Sample Type	Latitude	Longitude	Depth (m)	Analysis
07-25	Bell 9	sediment	63.5374	-68.38105	88.79	Microbiol., HC
07-25	Bell 10	sediment	63.5941	-68.33448	97.19	Microbiol., HC
07-25	11C	sediment	63.1651	-67.5518	369.72	Microbiol.
07-25	2017 Outer Bay A	water	63.1276	-67.43903	328.26	Microbiol., DOM
07-25	12C	sediment, water	63.0816	-67.42867	355.44	Microbiol., DOM, HC

07-26	13C	water	62.6867	-66.77247	211	Microbiol., DOM
07-26	2A	sediment	62.981	-67.37234	596	Microbiol.
07-26	20D	sediment, water	62.8439	-66.58893	151.29	Microbiol., DOM, HC
07-27	Sponge Site 5	water	60.4004	-62.90011	301.65	Microbiol., DOM
07-27	Non-Sponge Site 5	water	59.2247	-61.82626	150.68	Microbiol., HC
07-28	Non-Sponge Site 3	water	59.3824	-60.26768	601.7	DOM
07-29	Non-Sponge Site 1	water	59.5337	-58.63407	2378.36	Microbiol., HC
07-29	Saglek Deep	sediment, water	60.453	-61.25635	516.57	Microbiol., DOM, HC
07-29	DFO-1	water	60.4635	-61.26449	506.5	Microbiol.
07-30	Sponge Site 4	water	60.4597	-62.12046	368	DOM
07-31	DFO-750	water	60.4672	-61.21773	744.11	Microbiol.
08-01	DFO-5	sediment, water	60.4669	-60.59771	1416.52	Microbiol., HC
08-02	DFO-7	sediment, water	60.4669	-60.38003	1940.02	Microbiol., DOM
08-03	DFO-8	sediment, water	60.4685	-59.25748	2415.08	Microbiol., HC
08-03	DFO-9	water	60.471	-58.81319	2489.32	Microbiol., DOM, HC
08-04	DFO-11	water	60.4413	-57.09002	3026	Microbiol.
08-05	Hatton Basin	water	61.4373	-60.66732	621	Microbiol.
08-07	Lophelia	water	60.3697	-48.46247	700	Microbiol., DOM, HC
08-09	NLSE07	water	63.2509	-54.1989	1175.2	Microbiol.
08-09	SW Greenland 1	water	63.998	-55.50314	1078.23	Microbiol., HC
08-10	Disko Fan	sediment, water	67.9787	-59.51255	910.6	Microbiol., DOM, HC

Sediment Push Coring

Samples for hydrocarbon analysis were collected using 5 or 10 cm diameter plastic push cores from the box core. The sediment core was subsequently placed on a manual extruder and sectioned at 1.0 cm intervals for the first 10 cm, 2.0 cm for intervals between 10-20 cm, and 5.0m for the remainder of the core (up to 30cm total). Sediment from each section was split into two with one half wrapped in aluminium foil and stored in Ziplock plastic bags and the other half stored in Whirl-Pak bags. Sediment samples were stored at -20°C.

Water Sampling

Seawater samples (30 L; surface and bottom) were sampled for microbial community and geochemical analysis from the stations listed in Table 18.1. Water from an additional depth (50% to bottom) was collected at selected stations. Water was sampled from Niskin bottles fitted onto the Rosette sampler into clean Nalgene carboys (5L), amber glass bottles (5L). Surface water for hydrocarbon analysis was collected from the water's surface using plastic buckets (20L).

Water from the Nalgene bottles was filtered through 0.4 µm Pall membrane filters using a vacuum pump and filtration manifold (Figure 18.1). Filters were stored in Whirl-Pak bags at -80°C for future DNA extraction and sequencing of the 16s rRNA genes. Additionally, these water samples

were fixed for cell preservation in 37% formaldehyde in 2 mL cryovials and stored at 4°C for future cell counting.

Figure 16-1 Manifold used for water filtration of water for microbiology

Water from the amber glass bottles was filtered through 0.2 µm inline membrane filters. The filtrates of this filtration were acidified to pH 2 using hydrochloric acid and the dissolved organic matter (DOM) was extracted with methanol using solid phase extraction (as per Dittmar et al., 2008) with a steryne-divinylbenzene polymer sorbent (Agilent Bond Elut PPL, 5 g). Methanol extracts were stored in the dark in glass vials at -20°C for future Fourier transform ion cyclotron resonance mass spectrometry (FTICR-MS) analysis to characterize the dissolved organic carbon.

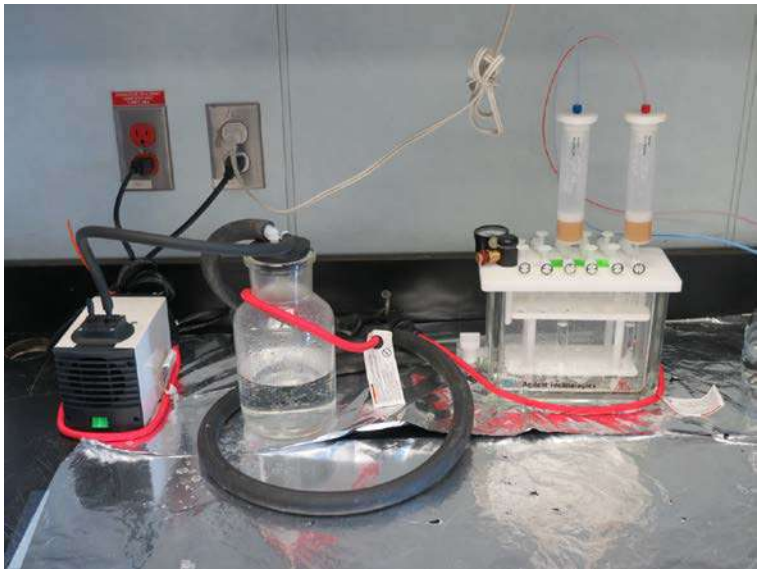

Figure 16-2 Solid phase extraction apparatus for DOM extraction

Surface water from the plastic buckets and 20L of bottom water from the Rosette was spiked with deuterated alcanes and pH standards then filtered though a 0.2 µm Pall membrane filter. Organic molecules were extracted from the filtrate using an SPE cartridge (Figure 18.3) for future analysis of hydrocarbon concentration.

Figure 16-3 Filtering and organic matter trapping apparatus for hydrocarbon measurement

16.2.2 *Sediment Sampling along a Hydrocarbon Seep Transect*

While on board the CCGS *Amundsen* water was sampled from the CTD Rosette (surface, bottom and a site 50% from the bottom) at sites listed in Tables 13.3-13.6. The water sampling pattern is shown in Figure 18.4. A remotely operated vehicle (ROV) was used to take surface material from the seafloor at three (3) locations along a transect originating at a suspected hydrocarbon seep (as identified by the presence of microbial mats and bubbles; Figure 18.5).

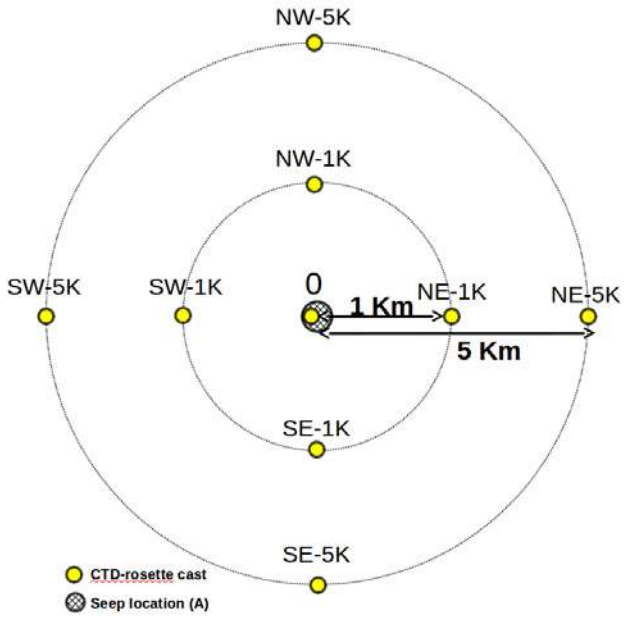

Figure 16-4 Water sampling transect at a seep at Scott Inlet (courtesy of Anirban Chakraborty). Coordinates for the sample sites are listed in Table 3. ROV dives occurred at sites 0, NE-1K, and NE-5K.

ROV Seafloor Material Sampling

An ROV was used to gather sediment using 2 spatulas attached to each arm at 3 sites along a transect originating at a hydrocarbon seep. The sites sampled by the ROV are listed in Table 18.2. The material sampled by the ROV was placed in a bucket inside the ROV sample drawer (Figure 18.5). After adding the sample material to the bucked the drawer was closed and not opened again during the dive to minimize water movement above the sample bucket to avoid contamination, flushing, or washing of the sample. On the surface, the ROV recovered samples were put into Whirl-Pac bags and stored at 4°C for future incubation or at -80°C for genomics . Some ROV sampled material was placed inside aluminium foil in Ziplock bags and stored at -20°C for the analysis of dissolved organic material. ROV recovered samples were also stored in small plastic containers for hydrocarbon analysis.

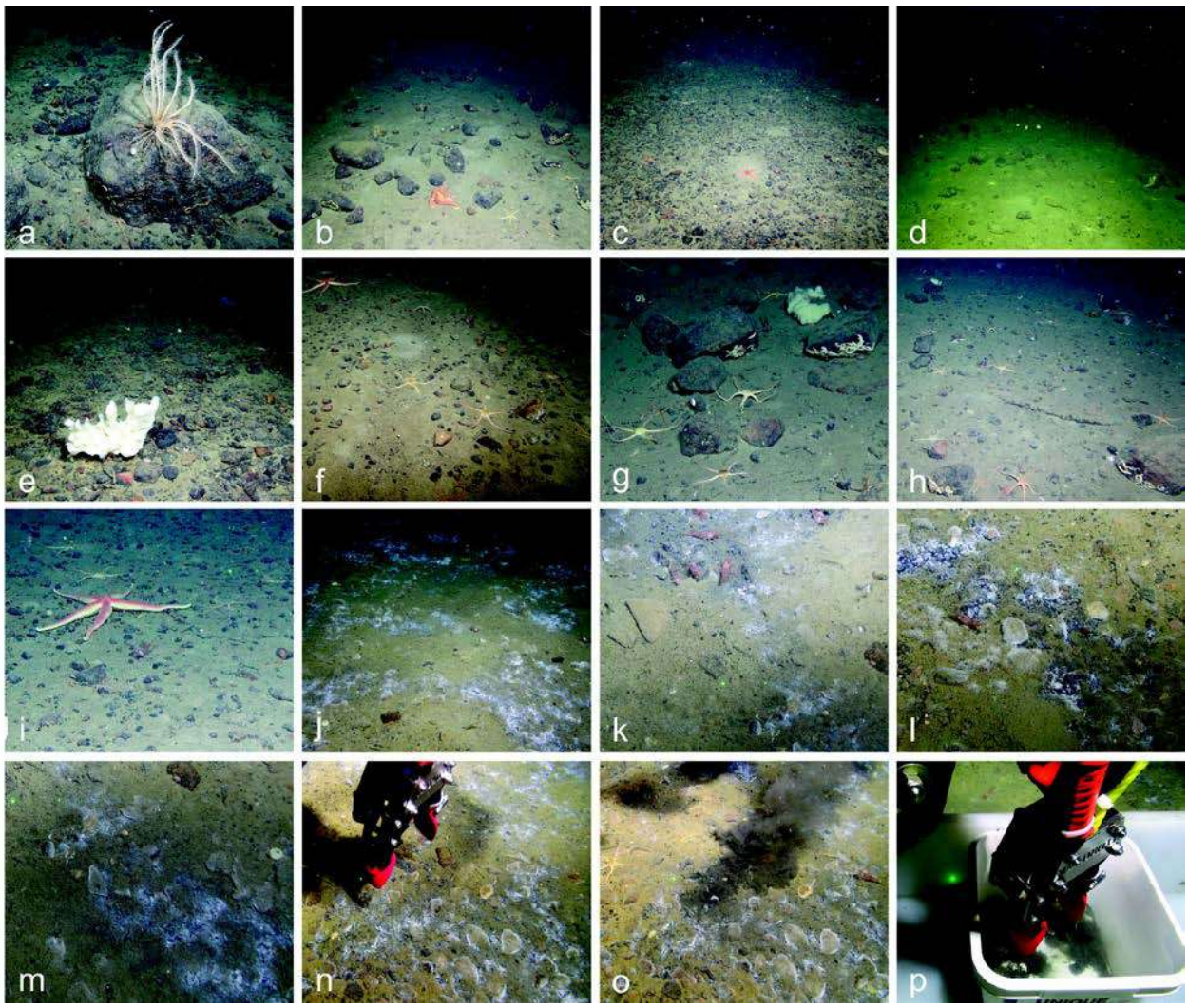

Figure 16-5 Photos taken during the ROV dive 70 at Scott Inlet Station 0.
Panels a,b,c,2,f,g,h,i,k show the marine life at the seafloor of Station 0 which included crinoids (a), brittle stars (b,c,f,g,h,i), sponges (e,g), and shrimp (k). Panels j-o show the microbial mats identified at Station 0 (bright white). Panels d and o show bubbles seen at Station 0. Panels n and p show the method by which the ROV arm sampled the seafloor material. Photo courtesy of Vonda Wareham Hayes.

Table 19-2 Seafloor material collected by ROV at Scott Inlet during Leg 2C of ArcticNet 2018

Date	Station ID	Dive	Latitude	Longitude	Depth (m)	Analysis
2018-08-12	Station 0	70	71.37812	-70.07452	262	Microbiol., DOM, HC
2018-08-12	NE-1K	71	71.38553	-70.05275	257.33	Microbiol., DOM, HC
2018-08-13	NE-5K	72	71.4096	-69.97168	266	Microbiol., DOM, HC

Water Sampling

Water was sampled from 13 stations and filtered using the methods described in Section 1 (Table 19.3, Table 19.4, Table 19.5) . At select stations water from the surface and 50% from the bottom was sampled. Additionally, some samples were preserved for RNA and DNA analysis. Triplicate water from some stations was preserved in triplicate plastic bottles for incubation and stored at 4°C.

Table 19-3 Water samples collected for Microbiology at Scott Inlet during Leg 2C of ArcticNet 2018

Date	Station ID	Latitude	Longitude	Depth (m)	Sampling depth
2018-08-12	First Rosette	71.37635	-70.07686	259.95	bottom
2018-08-12	NE-1K	71.38654	-70.05215	254	bottom
2018-08-12	Station 0 Time 1	71.37711	-70.07255	262	bottom
2018-08-12	SW-5K	71.34725	-70.17225	226	bottom
2018-08-12	SW-1K	71.37226	-70.09275	251	bottom
2018-08-12	Station 0 Time 2	71.37965	-70.06951	265.1	surface, bottom
2018-08-12	NW-5K	71.40855	-70.17774	557.34	bottom
2018-08-13	NW-1K	71.38466	-70.09111	311.54	bottom
2018-08-13	Station 0 Time 3	71.37876	-70.07145	264.43	bottom
2018-08-13	SE-5K	71.35005	-69.96353	216.62	bottom
2018-08-13	SE-1K	71.37283	-70.0481	215.48	bottom
2018-08-13	NE-5K	71.40957	-69.9731	266	bottom
2018-08-13	Station 0 Time 4	71.37845	-70.07475	265	bottom

Table 19-4 Water samples collected for dissolved organic material (DOM) at Scott Inlet during Leg 2 C of ArcticNet 2018

Date	Station ID	Latitude	Longitude	Depth (m)	Sampling depth
2018-08-12	Station 0 Time 2	71.37965	-70.06951	265.1	surface, middle, bottom
2018-08-12	NE-1K	71.38654	-70.05215	254	surface, bottom
2018-08-13	NE-5K	71.40957	-69.9731	266	surface, bottom

Table 19-5 Water samples collected for hydrocarbon analysis (HC) at Scott Inlet during Leg 2C of ArcticNet 2018

Date	Station ID	Latitude	Longitude	Depth (m)	Sampling depth
2018-08-12	First Rosette	71.37635	-70.07686	259.95	surface, bottom
2018-08-12	NE-1K	71.38654	-70.05215	254	surface, bottom
2018-08-13	NE-5K	71.40957	-69.9731	266	surface, bottom

Methane was sampled from selected sites (Table 18.6). Water was collected in duplicate in 60 mL glass bottles and fixed with saturated HgCl and stored cool or at room temperature in the dark. Methane analysis will be done by Robert Izett using GC-MS.

Table 19-6 Water samples collected for methane analysis from Scott Inlet during Leg 2C of ArcticNet 2018

Date	Station ID	Latitude	Longitude	Depth (m)	Sampling depth
2018-08-12	NE-1K	71.38654	-70.05215	254	Bottom
2018-08-12	Station 0 Time 2	71.37965	-70.06951	265.1	surface
2018-08-12	Station 0 Time 2	71.37965	-70.06951	265.1	10 m
2018-08-12	Station 0 Time 2	71.37965	-70.06951	265.1	30 m
2018-08-12	Station 0 Time 2	71.37965	-70.06951	265.1	50 m
2018-08-12	Station 0 Time 2	71.37965	-70.06951	265.1	100 m
2018-08-12	Station 0 Time 2	71.37965	-70.06951	265.1	150 m
2018-08-12	Station 0 Time 2	71.37965	-70.06951	265.1	200 m
2018-08-12	Station 0 Time 2	71.37965	-70.06951	265.1	bottom
2018-08-12	NW-5K	71.40855	-70.17774	557.34	bottom
2018-08-13	NW-1K	71.38466	-70.09111	311.54	bottom
2018-08-13	Station 0 Time 3	71.37876	-70.07145	264.43	bottom
2018-08-13	SE-5K	71.35005	-69.96353	216.62	bottom
2018-08-13	SE-1K	71.37283	-70.0481	215.48	bottom
2018-08-13	NE-5K	71.40957	-69.9731	266	bottom
2018-08-13	Station 0 Time 4	71.37845	-70.07475	265	bottom

16.3 Acknowledgement

Thank you to Alec Aitken, Evan Edinger, Meghan Hamp, Bodil Lauridsen, Gustavo Guarin, Fatma Dhifallah, Shaomin Chen, Karl Purcell, and Camilla Parzanini for their assistance with box coring operations.

A very special thank you to Vincent Auger and Peter Lockhart for piloting and operating the ROV allowing for bottom material along the Scott Inlet transect to be directly and intentionally sampled. Your quick and creative troubleshooting allowed us to develop a plan for the unexpected and difficult sampling conditions of the Scott Inlet seep site. Additionally we would like to thank Barry Brake and Kandice Piccott for preparing the ROV for the dive at Scott Inlet. Thank you also to Philippe Archambault and Evan Edinger for creating a modified sampling plan that accommodated the difficult sampling conditions. We would also like to give a special thank you to Barbara de Moura Neves and Vonda Wareham Hayes for doing photography and GIS mapping during the ROV operations and Evan Edinger for his coaching during our ROV dives at Scott Inlet.

Thank you to Pascal Guillot and Solenne Caous for operating the Rosette and accommodating our many requests for water samples. Thank you to Robert Izett for methane analysis of Scott Inlet.

Thank you to chief scientist Philippe Archambault for his considerate and strategic planning of scientific operations allowing us to achieve all of our scientific sampling goals and making Leg 2C a success.

Finally, thank you to Commandant Claude Lafrance and the crew of the CCGS *Amundsen* for facilitating this safe and successful scientific expedition.

16.4 Reference

Dittmar, T., Koch, B., Hertkorn, N., Kattner, G. (2008). A simple and efficient methanol for the solidphase extraction of dissolved organic matter (SPE-DOM) from seawater. Limnol Oceanogr Methods 6: 230-235.

17 Biogeochemistry of the Arctic Ocean – Leg 3

Project leaders: Tim Papakyriakou[1] (Tim.Papakyriakou@umanitoba.ca), Philippe Tortell[2], Alfonso Mucci[3], Helmuth Thomas[4], Brent Else[5], Roberta Hamme[6]
Cruise participants – Leg 3: Alexis Beaupré-Laperrière[3], Robert Izett[2], Louise Delaigue[3], Wanying Ji[4], Cara Manning[2] and Zarah Zheng[2]
[1] *Centre for Earth Observation Science, University of Manitoba, Winnipeg, MB, Canada*
[2] *Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia, Vancouver, BC, Canada*
[3] *Department of Earth and Planetary Sciences, McGill University, Montreal, QC, Canada*
[4] *Department of Oceanography, Dalhousie University, Halifax, NS, Canada*
[5] *Department of Geography, University of Calgary, Calgary, AB, Canada*
[6] *School of Earth and Ocean Sciences, University of Victoria, Victoria, BC, Canada*

17.1 Introduction

Climate change is affecting the biogeochemical cycling of carbon and other dissolved gases within the Arctic Ocean. The Arctic Ocean itself has undergone significant change in recent years, with increasing sea surface temperatures, increased freshwater inputs and large reductions in sea ice cover, the latter leading to higher gas exchange rates and subsequent ocean acidification. In 2018, our group measured several gases and biogeochemical tracers to provide insight into chemical processes within the water column. We measured the three most prominent anthropogenic greenhouse gases, CO_2, CH_4, and N_2O (carbon dioxide, methane, and nitrous oxide). CH_4 emissions from the Arctic are expected to increase as a consequence of global warming due to the thawing of permafrost on land and methane hydrates in the ocean. N_2O emissions in a changing Arctic Ocean are highly uncertain since different microbial processes can produce or consume these gases.

We also measured N_2, O_2, and four noble gases (Ne, Ar, Kr and Xe) at select stations. Oxygen is a tracer of net photosynthetic production and N_2 is a tracer of denitrification (conversion of nitrate to N_2 by heterotrophic microbes in anoxic waters and sediments). Noble gases, which are chemically and biologically inert, can be used to parameterize physical processes in the ocean, and the insight from these measurements can be applied to biologically-active gases.

In addition to sampling at rosette stations we also visited 7 rivers to collect samples for geochemical analysis. While sea ice loss is the most visible impact of climate change on the Arctic Ocean, increases in river discharge and organic carbon supply (which is transported to the ocean, in part, by rivers) also have large impacts on biogeochemical cycling, and there is currently very little geochemical data on rivers in this region. This data is needed to understand the impact of rivers on the Arctic Ocean and identify the presence of river-influenced water in the ocean. Recent studies have shown extremely high CH_4 emissions from some Arctic lakes, however, data on CH_4 fluxes from Arctic rivers are extremely sparse, especially in the Canadian Arctic Archipelago. The sampling sites for this project were chosen from places that other groups have conducted geochemical sampling at least once within the past 5 years. In this program, we

collected samples for nutrients, DOC, and ion concentrations. We also collected samples for inorganic carbon parameters (DIC, alkalinity, pH), CH_4 and N_2O, and nitrate isotopic composition, that were not collected by previous groups.

17.2 Methodology

17.2.1 *Seawater Sampling*

Seawater was collected at a number of nutrient, basic, and full stations (Table 19.1) primarily from the ship's CTD rosette system. We collected seawater samples for the analysis of methane (CH_4), nitrous oxide (N_2O), dissolved inorganic carbon (DIC), total alkalinity (TA), pH, stable oxygen isotopes of water (^{18}O-H_2O), O_2, N_2O isotopes, and nitrate isotopes. We also collected samples for radium analysis at some surface stations (Table 19.2).

Seawater samples for pH measurement were analyzed onboard after each rosette cast by spectrophotometry, at room temperature (25°C) using Phenol Red and Cresol Purple indicators to measure absorbance at specific wavelengths, the ratio of which translates into pH values. Nutrient sample analysis for the river samples occurred on board. All other samples will be returned to laboratories for analysis.

Table 20-1 Rosette sampling stations for Biogeochemistry team

Stn	Type	Cast	Latitude (N)	Longitude (W)	Date	CH_4/N_2O DIC/TA pH ^{18}O	Noble	$^{15}NO_3^-$	$^{15}N_2O$
312	B	02	69 10.493	100 41.632	Aug 19 2018	√			
QMG1	B	03	68 29.400	99 53.078	Aug 21 2018	√			
QMG2	B	04	68 18.590	100 47.914	Aug 21 2018	√			
QMG4	B	05	68 28.734	103 25.974	Aug 22 2018	√			
QMG3	B	06	68 19.603	102 56.068	Aug 22 2018	√			
QMGM	B	07	68 17.950	101 44.503	Aug 22 2018	√			
322	B	08	74 29.934	80 33.355	Aug 27 2018	√	√	√	√
101	B	09	76 22.918	77 23.729	Aug 27 2018	√	√	√	√
101	N	10	76 23.039	77 23.147	Aug 28 2018	√		√	√
Near Trinity	N	11	77 27.720	75 54.215	Aug 28 2018	√	√	√	
115	B	13	76 19.927	71 10.994	Aug 29 2018	√	√	√	√
177	B	15	67 28.969	63 40.770	Sep 01 2018	√	√	√	

Table 20-2 Radium sampling locations

Lat (N)	Lon (W)	Date	Time (UTC)	Station (if applicable)

76 28.3236	76 44.4017	Aug 26 2018	16:14	
77 27.8802	75 52.7048	Aug 28 2018	13:09	Near Trinity
73 29.9582	68 23.3932	Aug 29 2018	01:40	
67 17.0752	63 54.5938	Aug 31 2018	19:02	Site 1.5
66 35.0585	61 41.2471	Sept 02 2018	16:33	

17.2.2 *River Sampling*

At each river, and one surface ocean station, we measured temperature, conductivity, and pH using probes and collected samples for CH_4 and N_2O concentration, DIC, total alkalinity, nutrients, dissolved organic carbon, major ions as well as isotopic tracers: $^{87}Sr/^{86}Sr$, $\delta^{18}O$-H_2O, $\delta^{2}H$-H_2O, and dual isotope ($\delta^{15}N$ and $\delta^{18}O$) analysis of NO_3- and N_2O. We did not measure pH on the river samples because our on-board setup for pH analysis was not capable of freshwater measurements. Nutrient samples from the rivers were analyzed on board by Gabriele Deslongchamps using an auto analyzer.

The list of river sampling sites is below (Table 19.3). We sampled from 7 of the 16 rivers on our list of potential sites developed before the cruise. We were very pleased with the amount of sampling we did because visited the four highest priority rivers and we stayed within the budget of 4 hours of flight time.

Table 20-3 River sampling sites during Leg 2b

River Name	ID	Date Visited	Arrival time [UTC]	Departure time [UTC]	Lat (N)	Long (W)
River in Le Feuvre Inlet, Prince of Wales Isl.	CMLFI	18-08-18	14:04	15:05	72 20.55	96 55.55
Simpson River*	CMSR2	18-08-19	19:42	20:47	67 42.15	100 35.99
Ellice River*	CMER	18-08-21	17:00	18:10	67 52.58	104 05.42
Tingmeak River	CMTR	18-08-21	18:20	19:25	68 14.09	104 56 .87
Garnier River, Somerset Isl.	CMGR	18-08-24	12:25	13:20	76 56.64	92 03.56
Cunningham River, Somerset Isl.	CMCR	18-08-24	13:45	14:04	74 01.18	93 38.43
Saaqu River	CMSR	18-08-26	21:14	21:35	73 47.61	86 58.97

* sites in Queen Maud Gulf Bird Sanctuary

17.3 Preliminary results

Nutrients and pH were analyzed on board and we present some of the data below.

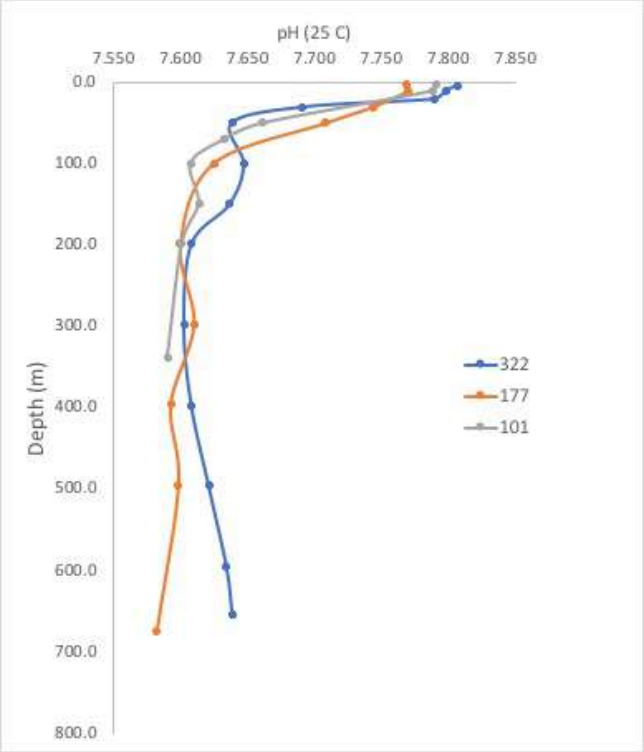

Figure 17-1 Profiles of mean pH measured spectrophotometrically with two coloured indicators at 25°C for stations 322, 177 and 101.

We present nutrient data from 5 stations in Table 20.4. Three of the rivers we sampled in 2018 were also sampled in 2017 (CMCR, CMGR, CMLFI), and the nutrient concentrations are comparable for the two years. We also note that the stations on continental North America within the Queen Maud Gulf bird sanctuary had much lower nitrate concentrations than any other rivers sampled in 2018.

Table 20-4 Nutrient data for selected rivers. The three rivers in the Queen Maud Gulf sanctuary (CMSR2, CMER, CMTR) show much lower nitrate concentrations than all other rivers sampled in 2017 and 2018.

River	Year	Nitrite	Nitrate	Phosphate	Silicate
		umol/L	umol/L	umol/L	umol/L
CMCR	2017	0.118	4.173	0.244	12.853
CMCR	2018	0.047	5.905	0.124	7.775
CMGR	2017	0.057	2.811	0.091	11.295
CMGR	2018	0.038	1.804	0.117	8.986
CMLFI	2017	0.068	1.726	0.023	15.124
CMLFI	2018	0.042	3.581	-0.031	14.277
CMSR2	2018	0.220	0.044	0.195	15.470
CMER	2018	0.108	0.051	0.053	13.548
CMTR	2018	0.104	0.052	0.133	9.863

17.4 Comments and Recommendations

We found the planning meeting very helpful and were very happy with the expedition plan presented before and following this meeting. We appreciate everyone's hard work to modify the expedition plan following the engine issues, to ensure as much science as possible could take place this summer.

Given that Leg 3 was truncated from 6 weeks to 2 weeks we think it would have been beneficial to seek additional input from all participants in Leg 3 about their highest priorities, to ensure the leg could be as effective as possible and that everyone's expectations were realistic before arriving on board. This leg didn't start until August so there would have been plenty of time to seek input and revise the expedition plan. We arrived on board for Leg 3 and after being delayed by a day due to cargo issues, we were presented with a list of the top priorities and what was likely to be cancelled during the science meeting. Many groups were surprised by this list and the amount of time allocated to different activities. For example, we were surprised that BB2 was not listed as a higher priority (given we had failed at sampling gases in the bottom water in two previous years and the rosette cable had finally been upgraded to enable deep water sampling) and that the Lancaster Sound stations were likely to be cancelled (this was our team's highest priority after BB2).

As a result of the cargo issues and two SAR calls during Leg 3, it was inevitable that some science operations would be cancelled. However, we feel that more science operations were canceled than was necessary and that the VIP event detracted from our scientific operations during Leg 3. We were disappointed with the decision that it was not possible to do even one deep cast at BB2 when other lower priority activities such as a nutrient cast at station 322 were completed. The Amundsen traveled within 15 nautical miles of the exact location of BB2 en route from station 115 to Qik, and the ship speed was reduced to 8 knots for about 12 hours beginning before dinnertime on Aug 30 so that we would not arrive to Qik early and have to anchor the ship overnight. We got the impression that scientific operations may have been cut short to add many hours of buffer time to the transit to the VIP event. The arrival of VIPs on the ship was not scheduled optimally, with a few people from Laval scheduled to board at 6:30 am and the remainder not arriving until after 9 am. Given that two thirds of Leg 3 was cancelled before we even arrived on board, we wish there had been more care taken to reduce the impact of this event on the scientific operations.

For future cruises, we request that Amundsen Science provide more assistance with rosette water budgeting in advance of each leg. The process of figuring out the rosette sheets on board is chaotic and often leads to the casts not being organized optimally (e.g., this year there was some confusion about the historical sampling depths). The standard rosette sheets for nutrient/basic/full stations should be figured out well in advance of the cruise. Users would be asked to modify their water requests if they cannot get as much water as they originally requested. Our labs are involved in many different oceanographic cruises and the Amundsen

Science expeditions are the only cruises we've encountered where the rosette sheets/water budget is not prepared in advance of the cruise and distributed to all participants for review.

During Leg 2c our team had to reduce our sampling resolution on many casts as we were not aware that some groups would be requesting full niskins to themselves on the same casts as the nutrient sampling. We are happy to compromise to ensure everyone on board can meet their scientific goals, but Amundsen Science should be enabling communication between all rosette users well in advance of the cruise to establish the water budgets, rather than expecting the rosette operators to negotiate the water budgets on board in the frenzy before the first rosette cast.

It would also be very beneficial to have a rosette user meeting at the start of each leg (every time new scientists board). This would provide an opportunity for everyone to describe their water sampling plan, what types of measurements/experiments they will be conducting, and any precautions rosette samplers need to take to avoid contaminating each other's samples (e.g. sticking to the sampling order, wearing a certain type of gloves, etc.).

We would like to thank Anissa and Alex for all of their work to obtain scientific permits for the helicopter sampling of bird sanctuaries and national parks. We were thrilled to sample three rivers in the Queen Maud bird sanctuary this year.

18 Assessing Microbial Diversity in the Canadian Arctic using Molecular Tools – Leg 3

Project leaders: Connie Lovejoy[1] (Connie.Lovejoy@bio.ulaval.ca),
Cruise participant – Leg 3: Nastasia Freyria[1]
[1] *Institut de biologie Intégrative et des systèmes, Université Laval, Québec, QC, Canada*

18.1 Introduction

Microbial communities, from all three domains of life, form the basis of marine food webs and have an important role in all biogeochemical cycles. Their distribution in the water column reflects water mass history as well as access to light and nutrients, and they are linked to the benthic community through processes such as sedimentation.

While microbial communities are highly diverse, the majority of organisms cannot be cultured, and are virtually impossible to distinguish morphologically. We must therefore use molecular tools to describe their genetic and functional diversity. High throughput sequencing, qPCR, and fluorescent in situ hybridization are all examples of such tools. Our goal for the 2018 cruise in Baffin Bay and areas of Lancaster Sound as well as the Queen Maud Gulf, was to collect samples for DNA- and RNA-based analyses, conventional and epifluorescence microscopy, and flow cytometry. These samples will be analysed in the laboratory at Université Laval.

18.2 Methodology

18.2.1 *Sampling Overview*

In 16 August – 7 September, seawater was collected at all “Full” and “Basic” station. Seawater was collected using the CTD-rosette system on board the CCGS *Amundsen*, with the option of sampling up to 8 depths per station (Table 20.1). Depths were chosen for sampling based on characteristics of the water column as profiled by the downcast of the CTD. The surface and bottom of the water column and the subsurface chlorophyll maximum (SCM) were always sampled, along with other depths of interest such as the nitricline, or temperature and oxygen features indicating interleaving water masses.

18.2.2 *DNA and RNA*

Samples for DNA and RNA were collected by filtering up to 6 litters of seawater onto a 3 µm polycarbonate filter and a 0.2 µm Sterivex cartridge (Millipore) using a peristaltic pump. This method gives us access to two distinct size fractions of the microbial community. Filters were stored in RNA later buffer (Ambion) at -80ºC. Both DNA and RNA will be extracted upon returning to Université Laval; the first represents simple presence of the cell or gene, while the second indicates the community's capacity for protein production, sometimes conceptualized as the “active community” since it excludes cysts and dormant cells.

Because RNA in particular degrades at ambient temperature, filtering was stopped after a maximum of three hours, meaning that sometimes less than 6 litters was filtered. Sometimes, the filtration was quite slow; probably due to dense microorganisms in the different water masses. Sometimes, two polycarbonate filters (3 µm) were used during the filtration. As regarding metagenomes samples, the method of filtration was the same as for DNA and RNA.

18.2.3 *Epifluorescence Microscopy*

Slides were made for epifluorescence microscopy at each station and depth sampled. These slides will be used to estimate abundance of eukaryote cells. Seawater was fixed with 50 % glutaraldehyde and processed within 24 hours of sampling. Forty-six ml of fixed sample was filtered through a 0.8 µm black polycarbonate filter and stained with DAPI, a nucleic acid stain. This filter was mounted on slide using a drop of immersion oil and stored in darkness at -20ºC.

18.2.4 *Flow Cytometry (FCM)*

FCM is more accurate than microscopy to count cells in the “pico” size range (0.2–2 µm) and can include some functional information such as prokaryote versus eukaryote cells and the presence of photosynthetic pigments. FCM samples were taken from each station and depth and fixed with 25% glutaraldehyde in duplicate for “dead” samples or preserved in glycerol-TE buffer in triplicate for “live” samples. After a short incubation at ambient temperature in the fixative or buffer, samples were flash frozen in liquid nitrogen and stored at -80°C.

18.2.5 *Fluorescent* in situ *Hybridization (FISH)*

FISH is a technique that uses fluorescent-labelled nucleic acid probes to identify a specific phylogenetic group of organisms under the microscope. Samples for FISH were collected in duplicate for eukaryotes and bacteria at each station and depth sampled. Seawater was fixed with 37 % formaldehyde and processed within 24 hours of sampling. For eukaryotic organisms, 175 ml of fixed sample was filtered onto a 0.8 µm polycarbonate filter. For bacteria, 50 ml was filtered onto a 0.2 µm polycarbonate filter. Filters were stored at -80 ºC.

18.2.6 *Conventional Light Microscopy*

At each station, for the surface water sample and SCM (where present), 225 ml of seawater was collected and fixed using FNU fixative (1 % paraformaldehyde, 0.1 % glutaraldehyde). At Université Laval, these samples will be allowed to sediment in Utermöhl chambers and larger organisms, such as diatoms and dinoflagellates, will be identified to the highest possible taxonomic resolution on an inverted microscope.

18.2.7 *Synopsys*

With the samples we have collected for molecular and microscopic analyses, we hope to arrive at a more detailed understanding of the phylogeny, structure, and function of microbial communities in the Canadian Arctic.

Table 21-1 Number of depths sampled for each cast and station

Stations	Rosette Cast	Number of Depths
312	1	7
QMG-1	3	3
QMG-2	4	4
QMG-4	5	4
QMG-3	6	3
QMG-M	7	4
322	8	4
101	9	8
Trinity	11	5
115	12/13	8
177	14	5

18.3 Comments and Recommendations

It was a long journey to finally arrived to Resolute Bay and onboard, due to heavy cargo to transport from Québec.

Due to two rescue operation, we were delayed to sample at each station initially planned, but we manage to sample at least two stations (101 and 115) at Northern Baffin Bay.

We did sample at two important stations in Northern Baffin Bay. The sampling of the rosette was well organised, we did have almost all the time enough depths to choose to sample.

Acknowledgement

I thank Chief Scientist Alexandre Forest for a well-organized cruise and finding good solutions to our complicated schedule. He handled well the constant changing plan. I thank Captain Claude LaFrance and the crew of CCGS *Amundsen* for their professionalism and dedicated support of our research. We had good weather and sampled whenever we were able to do it. The lab space allocated allowed good working conditions. I thank the team rosette for being ready every time and being patient with our demand and the good working, as well as the very good atmosphere. I also thank Tim Rodgers for using his bucket to sample surface water.

19 Davis Strait – Biogeochemistry Over Sponge Beds And Cold-Water Coral Reefs – Leg 2

Project leader: Dick Van Oevelen[1] (Dick.van.Oevelen@nioz.nl)
Cruise participant – Leg 2: Sabena Jane Blackbird[2]
[1] *Royal Netherlands Institute for Sea Research - NIOZ-Yerseke, Yerseke, Netherlands,*
[2] *School of Environmental Sciences, University of Liverpool, Liverpool, Merseyside, United Kingdom*

19.1 Introduction

The EU Horizon 2020 funded ATLAS project Work Package 2, led by Dick van Oevelen 'Functional Ecosystems' aims to understand how Atlantic ecosystems function and interact – providing predictive models at management relevant spatial scales. This will enable better predictions about how these ecosystems will adapt to a rapidly changing climate, carbon flux and resource exploitation.

The Davis Strait, Eastern Arctic is one of the three case study sites for ATLAS WP2. The Davis Strait separating western Greenland and Baffin Island is the world's largest strait and is renowned for exceptionally strong tides, ranging from 9 to 18 m, and complex hydrography. The slopes along the Labrador Sea flank of a ridge extending between Greenland (at Holsteinborg, Sisimiut) and Baffin Island (at Cape Dyer) and farther south along the Labrador and West Greenland shelves support sponge grounds and cold-water corals including the only known Lophelia pertusa reef in Greenlandic waters.

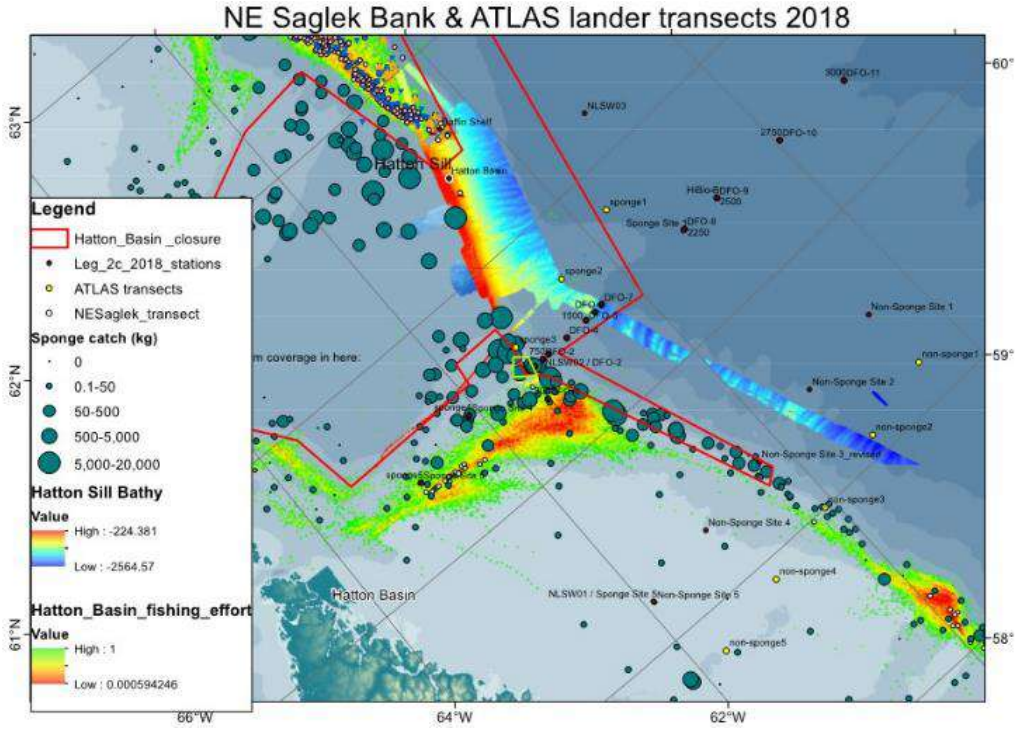

Figure 19-1 NE Saglek Bank & ATLAS lander transects 2018

Our key objective is to gain in-depth understanding of the food sources and food delivery pathways to the sponge grounds and cold-water coral reefs in the area. To enable this we aimed to sample the organic matter and food distribution in the water column across the shelf stations using a number of biogeochemical parameters listed in the methodology.

19.2 Methodology

Two CTD shelf/slope transects across the Sponge Site and Non Sponge Site ATLAS lander stations (5 CTD points for each transect), with sampling at 5 depths:-

1) surface – typically 5m below surface occasionally 2m below surface
2) chlorophyll max
3) mid-water - evaluated on CTD downcast at the lower end of the deep thermocline
4) 50mab
5) 10mab

Seawater collected from CTD rosette Niskin bottles into 9l carbuoys – two for each sampling depth. Sample water mixed thoroughly in carbuoy before measuring the following variables at all sampling points:

- Nutrients – Using disposable 10ml syringe, syringe rinsed with sample water (3 times). Disposable PE filter (0.45 um) screwed onto syringe. 5 mL pony vial rinsed with filtered sample water (3 times). 4 mL of sample water filtered into pony vial. Labelled & stored in -20oC freezer. Nutrients – Nitrate+Nitrite, Nitrite, Silicate, Phosphate and Ammonium to be analysed by 5-channel segmented flow autoanalyser (NIOZ)

- DOM (dissolved organic matter) – Using 20 mL glass syringe, syringe rinsed with sample water (3 times). 25 mm pre-ashed GF/F filter placed in polycarbonate filter holder. 5ml glass vial rinsed with filtered sample water (3 times). 4 mL of sample water filtered into glass vial. Labelled & stored in -20oC freezer. Syringe and filter holders cleaned in 10% HCl bath and rinsed in Milli-Q water between stations.
  DOM – DOC (dissolved organic carbon) and TDN (total dissolved nitrogen) to be analysed by high-temperature catalytic oxidation (HTCO) using a Shimadzu TOC-Vcph (NIOZ)

- POM (particulate organic matter) – Using forceps 47 mm pre-ashed and pre-weighed GF/F filter placed in Millipore Filter holder x 2 – i.e. filter A & B. Volume of sample water filtered through the duplicates via filtration rig under vacuum noted. Filter rinsed with approx. 10 ml ammonium carbonate solution (40g/l). Filter removed using forceps and placed into Petri dish. Labelled, placed in zip lock bag. Stored in -20oC freezer. POM - the quantity of PC (particulate carbon) and PN (particulate nitrogen) on the GFF filters will be determined by elemental analysis using a Thermo Scientific Flash Smart OEA. Filters will be de-carbonated using an acid-vapour technique and POC (particulate organic carbon) determined as above (University of Liverpool)

- •Pigments – Using forceps 47 mm GF6 filter placed in Millipore Filter holder x 2 – i.e. filter A & B. Volume of sample water filtered through the duplicates via filtration rig under vacuum noted. Filter removed using forceps and folded in half (to keep algae on the filter). Wrapped aluminum foil, labelled, placed in zip lock bag. Stored in -80oC freezer. Pigments - chlorophyll a, b, and c analysed using HPLC (High Performance Liquid Chromatography) (NIOZ)

- Flow Cytometry samples (bacteria / viruses) – Using Eppendorf auto-pipette 1 mL of sample water transferred into 2ml cryovial, using auto-pipette 20 µl glutaraldehyde EM grade added. Cryovials cooled at 4oC for 30 mins. After cooling, flash frozen in liquid N_2. Labelled & stored in -80oC freezer.
  To be analysed using a flow cytometer (NIOZ)

- Flow Cytometry samples (Phytoplankton) - Using Eppendorf auto-pipette 3.5 mL of sample water transferred into 5ml cryovial, using auto-pipette 100 µl Formaldehyde buffered with 18% hexamine added. Cryovials cooled at 4oC for 30 mins. After cooling, flash frozen in liquid N_2. Labelled & stored in -80oC freezer.
  To be analysed using a flow cytometer (NIOZ)

In addition surface water and chlorophyll max were sampled at Sponge Sites 1-4 for Lipid biological markers.

- Lipids – Using forceps 47 mm pre-ashed GF/F filter placed in Millipore Filter holder x 2 - i.e. filter A & B. Volume of sample water filtered through the duplicates via filtration rig under vacuum noted. Filter removed using forceps and placed into aluminium foil lined Petri dish. Labelled, placed in zip lock bag. Stored in -20oC freezer.
  The organic chemical composition (quality) will be assessed by quantitative determination of lipid biological markers such as polyunsaturated fatty acids (PUFAs), alcohols, sterols etc. using a Thermo Scientific TSQ 1400 Gas Chromatography – Mass Spectroscopy (GC-MS). Further compound specific isotope analysis of the lipids will involve Thermo Scientific Isotope Ratio – Mass Spectrometry (IR-MS) (University of Liverpool)

The schedule also permitted CTD stations across the shelf ridge between the lander stations at DF0-1 Saglek Bank, DF0-3 Saglek Deep and DF0-750 to be sampled at the 5 depths for variables noted above. The Lophelia pertusa site was sampled from Rosette cast 1 at the 5 depths for POM and Lipid biomarkers. In total nearly 800 litres of seawater was filtered!

Table 23-1 Summary of ATLAS Stations Sampled

	Sponge Site 5	Non Sponge Site 5	Non Sponge Site 4	Non Sponge Site3	Non Sponge Site 2	Non Sponge Site 1	DFO-1 Saglek Bank	Sponge Site 4	Sponge Site 3	DFO-3 Saglek Deep	DFO-750	Sponge Site 2	Sponge Site 1	Lophelia Site
Lat N	60 ° 24.030	59 ° 13.484	59 ° 18.647	59 ° 22.990	59 ° 28.547	59 ° 32.018	60 ° 27.809	60 ° 27.614	60 ° 28.051	60 ° 27.974	60 ° 27.864	60 ° 27.911	60 ° 28.111	60 ° 22.229
Lon W	060 ° 54.018	059 ° 49.585	061 ° 1.004	059 ° 16.097	059 ° 26.686	058 ° 38.125	061 ° 15.767	061 ° 7.021	061 ° 17.724	061 ° 6.454	061 ° 12.983	060 ° 23.046	060 ° 15.420	048 ° 27.854
Surf.	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM, Lipids	Nuts, DOM, Pigs, B & V, Phyto, POM, Lipids	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM, Lipids	Nuts, DOM, Pigs, B & V, Phyto, POM, Lipids	POM, Lipids
DCM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM, Lipids	Nuts, DOM, Pigs, B & V, Phyto, POM, Lipids	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM, Lipids	Nuts, DOM, Pigs, B & V, Phyto, POM, Lipids	POM, Lipids
Mid	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	POM, Lipids
50mab	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	POM, Lipids
10mab	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	Nuts, DOM, Pigs, B & V, Phyto, POM	POM, Lipids

19.3 Acknowledgement

Thanks to CTD Rosette operators Pascal Guillot and Solenne Caous of Amundsen Science along with the captain and crew of the CCGS *Amundsen* - especially those involved in rosette operations, for their dedication during an intensive station sampling schedule.

20 Isolation and Characterization of Hydrocarbon Bacteria and their Biodegradation Potential – Leg 1

Project leader: Gary Stern[1] (gary.stern@dfo-mpo.gc.ca)
Cruise participant – Leg 1: Pardis Karimi[1]
[1]*Centre for Earth Observation Science, University of Manitoba, Winnipeg, MB, Canada*

20.1 Introduction

The most common environmental pollutants are Petroleum hydrocarbons, including n-alkane, cycloalkane and aromatic hydrocarbons that have been considered as serious ecological and public health concerns. Ecosystem contamination by crude oil hydrocarbons is a fundamental worldwide topic accompanying with crude oil drilling, transportation, refining and related activities which demands immediate attention for restoration. Bioremediation has been showed to be a promising, environmental friendly and economical method for mineralization of hydrocarbons to carbon dioxide and water. Due to great catabolic diversity of microorganisms, they are the best candidates among all living organisms to mineralize xenobiotic compounds into natural biogeochemical cycles. As such, the aim of Leg 1 was to collect environmental samples and to isolate oil degraders through different screening procedures in the home laboratory.

As only DNA characterization cannot be a good representative of the bacterial population in a habitat, (e.g. some of the bacteria has smaller size than the filter pore size so, they filter through), onboard enrichment methodology was used to isolate cultivable and then compare the results with molecular characterization. The rest of experiments based on the main objectives of the project will be done at the University of Manitoba.

20.2 Methodology

20.2.1 *Sample Collection*

Samples were collected from the ships route in Hudson strait and Hudson Bay to find active oil degraders and see the differences in bacterial species present in surface and bottom water, surface and bottom sediments, ice cores, and sea-ice water interface at each location. Samples included:

- surface seawater ;
- bottom seawater ;
- ice cores ;
- melt ponds ;
- sea ice interface water ;
- surface sediments ;
- bottom surface sediments.

20.2.2 *Sample Processing*

Seawater

15 liters of surface and bottom water were collected in clean buckets from each station and filtered through 0.2 µm filters by vacuum filtering system immediately after collection.

Water samples were processed separately for:

- RNA analysis;
- DNA analysis;
- Enrichment.

Samples after proper processing preserved at -80°C for further analysis in the home laboratory at the University of Manitoba.

A separate set of water samples from surface and bottom of each station also was taken for salinity, nitrate, nitrite, DOC, and pH analysis, to be done at the University of Manitoba.

Enrichment done onboard and the rest of analysis and bacteria isolation/molecular characterization will be done at the University of Manitoba. Great care was taken to keep the aseptic condition throughout culturing, filtering, and preservation.

Ice

Collected samples included:

- Ice core;
- Sea-ice water;
- Melt pond, if any.

15 liters of ice samples were collected from each station and filtered through 0.2 µm filters by vacuum filtering system immediately after collection.

Ice samples processed separately for:

- RNA analysis;
- DNA analysis;
- Enrichment.

Samples after proper processing preserved at -80°C for further analysis in the home laboratory at the University of Manitoba.

A separate set of water samples from surface and bottom of each station also was taken for salinity, nitrate, nitrite, DOC, and pH analysis, to be done at the University of Manitoba.

Enrichment done onboard and the rest of analysis and bacteria isolation/molecular characterization will be done at the University of Manitoba. Great care was taken to keep the aseptic condition throughout culturing, filtering, and preservation.

Surface and Bottom Surface Sediment Samples

Sediment samples collected by push core. Oxic and anoxic part of marine sediment samples collected separately to be used for:

- Enrichment;
- Hydrocarbon extraction;
- TOC;
- TN;
- pH;
- Texture and structure

Enrichment done onboard and the rest of analysis and bacteria isolation/molecular characterization will be done at the University of Manitoba. Great care was taken to keep the aseptic condition throughout culturing, and preservation.

20.3 Preliminary Results

All the DNA and RNA analysis will be done at the University of Manitoba. Preserved bacteria samples after onboard enrichment will be further analysed at the University of Manitoba to isolate each bacteria based on morphological, biochemical, and molecular characteristics. Biodegradation assays also will be done at the University of Manitoba based on the outline of project.

Throughout the filtering process, it was observed that the biomass obtained from some of the stations and samples was considerably low by visual observation. Further investigation is required to understand the reason/explanation.

21 Baseline Hydrocarbon Concentration in Hudson Bay – Leg 1

Project leader: Gary Stern[1] (gary.stern@dfo-mpo.gc.ca)
Cruise participants – Leg 1: Diana Saltymakova[1], Nolan Snyder[1] and Teresinha Wolfe[1]
[1]Centre for Earth Observation Science, University of Manitoba, Winnipeg, MB, Canada

21.1 Introduction

Within the Northern Arctic, global warming has led to a persistent decrease in sea-ice extent and type. Consequently, shipping and oil exploration in the Hudson Bay is becoming more feasible, allowing for a potential of petroleum derived contamination in marine environment. This impending possibility has led to a need for understanding of:

Key question: How the surface sediment, surface and bottom water hydrocarbon concentrations differ throughout the Hudson Bay? At what scale crude oil spill may affect hydrocarbons concentration in Hudson Bay waters and what are the possible consequences of the spill.

Key questions: How do the hydrocarbon-degrading microbial communities of first year ice responds to HC amendment? How does crude oil chemical composition change in response to incubation during the time? How does nutrient availability/addition (N and P as NH4+ and PO43- respectively) affect the rate of petroleum hydrocarbon degradation?

21.2 Methodology

- Surface and Bottom Water was Sampled throughout Hudson Bay : 20 L filtered through 0.2 µm filter and SPE cartridge for analysis of particle and dissolved organic matter;
- Ice was sampled throughout Hudson Bay : 4 m of ice was melted, filtered through 0.2 µm filter and SPE cartridge for analysis of particle and dissolved organic matter;
- Sediment Sampling ; push cores were collected through the Hudson Bay and sliced every 1 cm first 10 cm, every 2 cm the second 10 cm and every 5 cm after that;
- Ice was sampled for Incubation at Station # 11 Located at Transportation Corridor : One full ice core was melted and was used as inoculum for microbial hydrocarbon degradation incubations with light crude oil. For each of the experimental conditions, three 1L bottles was set up to allow for larger volume sampling. Incubations will be sampled every 3 weeks for change in crude oil composition, microbial community succession, and cell counting.

22 Microbial Genomics for Oil Spill Preparedness in Canada's Arctic Marine Environment – Legs 1 and 2a

Project leader: Casey Hubert[1] (chubert@ucalgary.ca)
Cruise participants – leg 1: Michael Stone[1] and Oye Adebayo[1]
Cruise participant – leg 2a: Katrina Callender[2]
[1]*Department of Biological Sciences, University of Calgary, Calgary, AB, Canada*
[2]*Energy, Mining & Environment, National Research Council Canada, Montréal, QC, Canada*

22.1 Introduction

Oil spills are one of the most serious threats to marine ecosystems. Drilling accidents like the Deepwater Horizon spill in the Gulf of Mexico in 2010 and the Marathassa oil spill in English Bay, Vancouver in 2015 have highlighted the need for better preparedness for such events. With escalating marine traffic and potentially significant prospects of oil and gas development, the Arctic is faced with an increasing risk of oil pollution.

One approach to mitigating oil in marine waters is through bioremediation, whereby naturally present microorganisms biodegrade oil (hydrocarbons) reducing negative impacts of the spill. The extent and success of using bioremediation to treat oil in the Arctic marine setting is relatively unknown and requires further study. By using genomics to study the presence and activity of microorganisms with the potential to degrade oil under various Arctic conditions, efficient spill mitigation strategies can be developped.

Government, industry and indigenous organizations face knowledge, policy and capacity gaps with respect to oil spill mitigation, especially for ice-covered, sub-zero temperature marine waters and preparation measures among local, regional, national and international levels of governance. GENICE is a 4-year Genome Canada project lead by Drs. Gary Stern and Casey Hubert that will use microbial genomics to generate science-based evidence on the role and potential of bioremediation to deal with oil spills in the Arctic Ocean. This work will result in a "Best Practices" document concerning the bioremediation of oil spills in Arctic regions that will be shared widely with residents of potentially affected northern communities, various levels of government, non-governmental and indigenous organizations and the private sector.

The main objectives include:

- Baseline microbial genomics data useful for assessing marine ecosystem resilience and response to hydrocarbon pollution;
- Bioremediation viability case studies;
- Recommendations on technology-based emergency spill response strategies;
- Best practices for successful knowledge transfer and sharing of diverse knowledge types; and
- Mobilized sharing of genomics and bioremediation information for informed decision-making and policy development.

22.2 Methodology

22.2.1 *Leg 1*

The coordinates of stations sampled are shown in Table 25.1.

From each station, one or more of the following environmental materials were collected as samples.

- Surface sea water (SSW): collected from the deck;
- Bottom sea water (BSW): collected from the rosette at 10 m above sea bed
- Sea-ice (SI): collected using an auger at ice stations
- Sediment (SED): collected from the surface (0-5cm) of box cores

For each environmental material, the samples were preserved for DNA extraction, microcosm incubations and Cell Counts. Surface sea water and sea ice sub samples were preserved for viromics analysis.

SSW:

- Surface Sea Water was obtained from the deck via bucket sampling;
- Cells were fixed using 4% Formaldehyde for cell counts;
- Water was filtered through 47mm 0.2µm PES membrane filter to collect microbial organisms for baseline;
- A sub sample was used as an inoculum for an enrichment which will be used to isolate crude oil degrading micro-organisms from the environment;
- Extra water was taken at stations in key locations to establish a baseline viromic profile of the surface sea water.

BSW:

- Bottom Sea Water (10m above sea bed) was obtained via rosette sampling (chemical/CTD cast);
- Cells were fixed using 4% Formaldehyde for cell counts;
- Water was filtered through 47mm 0.2µm PES membrane filter to collect microbial organisms for baseline

SI:

- Full sea ice cores were obtained from ice floes via core barreling;
- The ice was then crushed and melted with a sub sample being saved for purpose of enrichment;
- Cells were fixed using 4% Formaldehyde for cell counts;
- Melted water was filtered through 47mm 0.2µm PES membrane filter to collect microbial organisms for baseline;
- The sub sample was used as an inoculum for an enrichment which will be used to isolate micro-organisms from the environment

SED:

- Sediment was obtained via box coring from the foredeck;

- Top sediment was sampled in triplicates from the first core, with an occasional quadruplicate coming from a second core;
- Cells were fixed using 4% Formaldehyde for cell counts
-

Table 26-1 List and coordinates of stations sampled

Stn	Samples	Latitude N (surface water)	Longitude W (surface water)	Latitude N (bottom water)	Longitude W (bottom water)	Latitude N (Box Core)	Longitude W (Box Core)	Date	Depth (m)
4	SSW, BSW	62, 2.425	069, 37.105	62;2.443	069;36.892	NA	NA	01-Jun	283
9	SSW, BSW, Ice	63; 43.734	079;55.686	63;43.248	079;55.362	NA	NA	03-Jun	91
10	Box cores (single Core)	NA	NA	NA	NA	63.451	079.445	04-Jun	100
11	Box cores, Ice, SSW, BSW	62;52.647	078;52.239	62;52.602	078;51.862	62.870	078.856	04-Jun	309
15	Box Cores, SSW, BSW, SSW Virus	63;10.512	081;50.983	63;10.512	81;50.983	63.184	081.860	05-Jun	
16	Box Cores, SSW, BSW, Ice	62;17.263	085;52.049	62;17.394	085;51.450	NA	NA	06-Jun	135
17	SSW, Box Cores, BSW	63;11.070	090;2.060	63;11.070	090;2.023	63.183	090.033	07-Jun	90
18	SSW, SSW virus, BSW, Ice, Box Cores	63;43.811	088;25.566	63;42.830	088;25.020	63.720	088.399	08-Jun	120
19	SSW, BSW, Sediment	61;50.834	092;7.962	61;50.834	092;7.962	61.843	092.131	09-Jun	70
21	SSW,BSW, Sediment, Ice	60;54.645	089;19.801	60;54.688	089;19.801	60.910	089.339	10-Jun	144
22	SSW, BSW,	60;25.290	094;0.194	60;25.272	094;0.194	NA	NA	11-Jun	63
28	Sediment, SSW, BSW	62;24.874	089; 49.945	62;27.838	089;49.883	62.416	089.820	14-Jun	160
29	Sediment, SSW, BSW	61;46.812	084;18.490	61;46.182	084;18.490	61.747	84.29308	16-Jun	175

32	SSW, BSW, Ice, Sediment	56;58.854	088;8.749	56;58.843	088;8.743	NA	NA	19-Jun	34
34	SSW, BSW,	56;30.008	086;52.052	56;30.006	086;51.971	NA	NA	20-Jun	43
36	SSW, Sediment, BSW	57;46.442	086 1.865	57;46.442	086;1.847	57.776	086.027	22-Jun	126
38	SSW, BSW, Ice, Sediment	58;43.825	086;18.065	58;43.847	86;18.065	58.724	086.298	23-Jun	177
40	SSW,BSW, Sediment	58;14.407	088;34.996	58;14.423	088;34.996	58.244	088.591	24-Jun	85
44	SSW, BSW	59;58.514	091;57.016	59;58.583	091 56.938	NA	NA	28-Jun	98
45	SSW, BSW, Sediment	57;13.247	091;57.213	57;13.164	091;57.427	57.252	91.963	30-Jun	16
46	SSW, BSW, Sediment	57;29.635	091;49.030	57;29.630	091;49.078	57.503	091.805	01-Jul	45

22.2.2 *Leg 2a*

Operational work on Leg 2a focused on establishing genomic baseline data on Arctic seawater thereby assessing the potential response and resilience of arctic marine ecosystems to hydrocarbon pollution.

Three (3) 2L filtrations of seawater (5m depth) were carried out per sampling station visited (Table 1). Water sampling for genomics was conducted, after gas and nutrient sampling by other teams, as follows: a clean (sterile) 10L Jerry can was rinsed thrice with seawater from the 5m Rosette Niskin bottle then used to collect 6.5 L of seawater. Seawater (2L) was then immediately filtered using a Millipore™ filtration manifold ramp and 47mm 0.22 µM Millipore™ filters, with the filtrate trap emptied after every 1L. Filters were aseptically transferred to sterile 20ml falcon tubes using alcohol (isopropanol)-sterilized tweezers and stored onboard at -80C for downstream analysis (nucleic acid, i.e., DNA and RNA, extraction).

Table 26-2 Stations sampled during Leg 2A

Station no.	GPS coordinates	Location
731 (732)	55° 24.5081' N 77° 55.0765' W	Kuujjuarpik, Hudson Bay

730	56° 11.2083' N 76° 43.1561' W	Umiujaq, Hudson Bay
736	58° 25.4133' N 78° 19.4050' W	Inukjuak, Hudson Bay
689	62° 20.5709' N 75° 32.0825' W	Salluit, Hudson Strait
341	61° 57.1850' N 70° 44.6169' W	Kangiqsujuaq, Hudson Strait

23 Northern Contaminants Program; Assessing Persistent Organic Pollutants in the Canadian Arctic – Leg 2a and 3

Project leaders: Liisa Jantunen[1] (liisa.jantunen@canada.ca) and Gary A. Stern[2]
Cruise participants – Leg 2a: Rachelle Robitaille[2] and Nicole Anne Ymana[1]
Cruise participant – Leg 3: Tim Rodgers[1]
[1] *Environment and Climate Change Canada, Egbert, ON, Canada*
[2] *Centre for Earth Observation Science, University of Manitoba, Winnipeg, MB, Canada*

23.1 Introduction

Long range transport of persistent organic pollutants (POPs) has been a focus of contaminants research since the late 1960s. The Arctic is known to be an important sink for POPs, as the temperature gradient and prevailing winds bring POPs from emissions sources in warmer climates (mainly North America, Europe and Asia) to their final resting place in the Arctic. This is of significant concern since POPs partition to organic matter and in the Arctic landscape much of the organic matter is found in the animals which make up a significant part of the diets of the residents. Research in the Canadian Arctic has been critical to developing an understanding of how long range transport occurs, and in crafting legislation (such as Canada's Chemical's Management Plan or Europe's REACH program) and international agreements (such as the Stockholm Convention) which regulate the usage and production of POPs. The Amundsen has long been an essential platform for this research, and we were lucky enough to once again get to take samples and participate in this cruise, allowing us to maintain a unique historical dataset, parts of which have been active since 1992. We intend to continue monitoring of POPs as well as new and emerging compounds with POP-like behaviour to observe their trends over time, and any impacts from climate change on the behaviour of POPs in the Canadian Arctic.

Our objectives on this leg was to collect water, air, zooplankton and sediment samples in the Canadian arctic to measure levels of compounds of concern, as well as new and emerging compounds. We also want to provide environmental sampling training to a northern student as part of ArcticNet's Schools on Board program.

This work is funded by the Northern Contaminants Program, ArcticNet and Environment and Climate Change Canada.

23.2 Methodology

23.2.1 *Water Sampling*

To analyze PFCs, we collected 1L above and below the thermocline using the rosette. To analyze OPEs, we collected 4L of surface water with the rosette if possible. If not, we bucket the water on the side of the ship. All water samples were stored in the refrigerator. Latitude, longitude, water temperature, salinity is recorded for each sampling.

23.2.2 *High Volume Water Sampling*

90-100L of water was collected by bucketing on the side of the ship. When bucketing, we made sure to rinse the bucket and containers well with the sea water at sampling location. This water is then pumped through an XAD column (HV column) to concentrate organics from the water. The columns are then stored in the refrigerator room. Latitude, longitude, water temperature, salinity, start and finish time is recorded for each sampling.

23.2.3 *Low-Volume Water Sampling*

We collected small volumes of water from the rosette to analyze for ionic PFCs and organophosphate esters (OPEs) which require different storage and analysis methods than our high-volume water samples. For the PFCs, we collected 1L in plastic bottles above and below the thermocline using the rosette. Many thanks to Thomas and Solene who identified the depths for the PFC samples. To analyze OPEs, we collected 4L of surface water in amber glass bottles with the rosette or through bucketing. We obtained low volume water samples either during stations or opportunistically when the ship was stopped. We stored the low volume water samples in the refrigerated laboratory, they will be returned to the ECCC lab for processing and analysis. Many thanks to Lars for assisting me in taking a PFC and an OPE sample while I was in Qikiqtarjuak during the Governor General's visit. We obtained 7 OPE samples and 2 blanks, as well as 12 PFC samples and 1 blank on this leg of the cruise (Table 24.3).

23.2.4 *High Volume Air*

The purpose of our air sampling campaign is to obtain trends of pesticides, POPs and other contaminants in the air of the Canadian Arctic, as well as to archive some samples for future analysis against novel compounds which may one day be of concern. These air samples are part of a dataset which this group has been running continuously since 1992. A pre-packed airhead consisting of a glass fiber filter to collect particles and a sandwich of polyurethane foam and XAD-2 resin that collects gas phase and very small particles was attached to a vacuum pump on a pole near the bow of the ship (Figure 24.1).

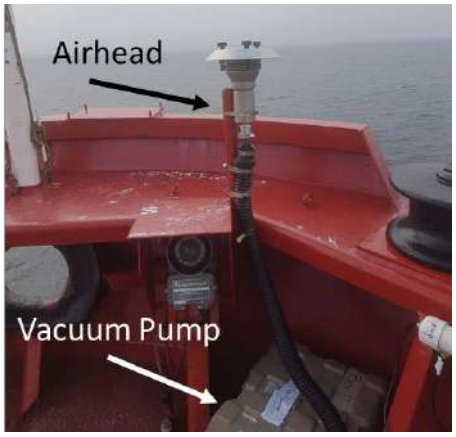

Figure 23-1 Airhead and vacuum pump at the bow of the Amundsen during Leg 3

The air samples were run for 48 hours each then stored in the deep freezer. They will be returned to the ECCC lab, where they will be processed and analyzed. For blanks, a sample airhead is opened, carried to the pump, installed and then run for 30min. Latitude, Longitude and Mag gage is recorded at the start and at the end of each sampling.

The target list for this project has been expanded over time, and includes current use pesticides, flame retardants, plasticizers, per-fluorinated compound (PFCs, neutral and ionic) and poly aromatic hydro carbons. We will also be screening for microplastics. Table 24.1 shows the air sampling activities during Legs 2a and 3.

Table 27-1 Active air sample times and locations

Leg	Sample ID	Lat/Long ON	Time ON	Lat/Long OFF	Time OFF	Time Elapsed (h)
2a	AN18AIR1	55°61.75547N 84°23.25082W	2018-07-07 10:03 AM	58°40.42215N 78°26.36575W	2018-07-09 10:02 AM	48
2a	AN18AIR BLK1	-	-	-	-	
2a	AN18AIR2	58°42.06448N 78°31.02588W	2018-07-09 10:22 AM	62°67.73432N 78°08.19433W	2018-07-11 10:22 AM	48
2a	AN18AIR3	62°67.68620N 78°02.68745W	2018-07-11 10:32 AM	61°96.3562N, 65°70.78772W	2018-07-13 10:30 AM	48
3	AN18AIR BLK2	-	-	-	-	
3	AN18AIR4	74°44.0959N, 95° 9.1033W	2018-08-17 03:25 PM	68°44.0884N 101°18.2929W	2018-08-19 03:40 PM	48
3	AN18AIR5	69°10.3393N, 100°42.3348W	2018-08-19 04:00 PM	68°44.2003N 104°51.7212W	2018-08-21 04:00 PM	48
3	AN18AIR6	74°11.5081N 89°30.5441W	2018-08-24 12:23 PM	73°29.4383N 88°34.4174W	2018-08-26 01:25 PM	49
3	AN18AIR7	73°29.4383N 88°34.4174W	2018-08-26 01:45 PM	76°53.9328N, 75°42.3994W	2018-08-28 02:05 PM	48
3	AN18AIR8	76°52.0558N, 75°41.0669W	2018-08-28 02:25 PM	69°25.3251N, 65°11.7234W	2018-08-30 05:25 PM	51
3	AN18AIR9	69°25.3251N, 65°11.7234W	2018-08-30 05:45 PM		2018-09-01 06:10 PM	48
3	AN18AIR10	67°26.1926N, 62°36.5769W	2018-09-01 06:35 PM	64°53.3658N, 62°38.3773W	2018-09-03 07:25 PM	49
3	AN18AIR11	64°53.3658N, 62°38.3773W	2018-09-03 07:25 PM	54°53.0238N, 56°29.7158W	2018-09-06 01:15 PM	66
3	AN18AIR BLK3	-	-	-	-	

23.2.5 *Particle Filtering*

Using the in-line water supply in the engine room, we wanted to filter approximately 1000L of water through a glass wool filter. Seeing as you cannot control the flow of the in-line water supply, we wanted to collect the ships data (TSG) to find out the flow for each hour to calculate the average and figure out when the 1000L mark is reached and can switch the filter. Unfortunately we were not able to set up the particle filter on this leg, as there were too many instruments using this in-line water supply.

Figure 23-2 Water particle filter holder on the PCO_2 line

We were unable to obtain these samples on Leg 2a and so we are grateful to Lou for setting it up Leg 3. The particle filters will be analyzed for POPs and contaminants of emerging concern, including pesticides, flame retardants, plasticizers, per-fluorinated compounds (neutral) and poly aromatic hydrocarbons. We took 15 samples and one blank on this cruise (Table 24.2)

Table 27-2 Particle filter sampling times and volumes (L)

Leg	Sample ID	Time ON	Time OFF	Flow Volume (L)	Time Elapsed (h)
2a	AN18PART1	Could not install	-		
3	AN18PART2	2018-08-18 06:25 PM	2018-08-19 07:30 AM	1145	13
3	AN18PART3	2018-08-19 07:30 AM	2018-08-19 07:30 PM	1046	12
3	AN18PART4	2018-08-19 07:30 PM	2018-08-20 08:30 PM	1107	25
3	AN18PART5	2018-08-24 12:45 PM	2018-08-25 07:10 AM	1314	18
3	AN18PART6	2018-08-25 07:15 AM	2018-08-25 09:50 PM	990	15
3	AN18PART7	2018-08-26 12:45 PM	2018-08-27 02:45 AM	1003	14
3	AN18PART8	2018-08-27 02:45 AM	2018-08-27 05:00 PM	730	14
3	AN18PART9	2018-08-27 05:00 PM	2018-08-28 11:35 PM	1035	31
3	AN18PART10	2018-08-28 11:35 PM	2018-08-30 10:55 AM	1345	35
3	AN18PART11	2018-08-30 10:55 AM	2018-08-31 11:15 AM	965	24
3	AN18PART12	2018-08-31 11:15 AM	2018-09-01 03:45 PM	1545	29
3	AN18PART13	2018-09-01 03:45 PM	2018-09-03 11:00 PM	1125	55
3	AN18PART14	2018-09-03 11:00 PM	2018-09-05 09:50 PM	1015	47
3	AN18PART15	2018-09-07 10:40 AM	2018-09-07 07:00 PM	1130	8
3	AN18PARTBLK1	2018-09-07 10:35 AM	-	-	-

23.2.6 *Sediment Sampling*

Sediment samples are taken opportunistically from the box corer and stored into a clean sealed jar in the freezer. There was no box coring during this leg, therefore we did not collect any samples.

23.2.7 *Zooplankton Sampling*

Zooplankton are also taken opportunistically from the different net tows. The zooplankton team put aside a small batch of what they caught in one of their nets for us to speciate and store in jars in the freezer. More than 15 individuals of one species have to be collected for analysis.

23.2.8 *Microplastics Sampling*

80L of surface water was collected to fill two clean large 40L metal containers. When bucketing, we made sure to rinse the bucket and containers well with the sea water at sampling location. For one sampling location, two filtrations are done (40L for each) using a Millipore Stainless Steel filter holder and a 142mm polycarbonate filter paper (1µm poresize). For each filtration one blank is done; 10L of filtered water is carried through the sample process as the sample and filtered again. In between samples, all equipment is rinsed three times with milliQ water and the filter is flushed with 1L of milliQ water. Latitude, longitude, water temperature, salinity, start and finish time, as well as what the sampler is wearing is recorded for each sampling.

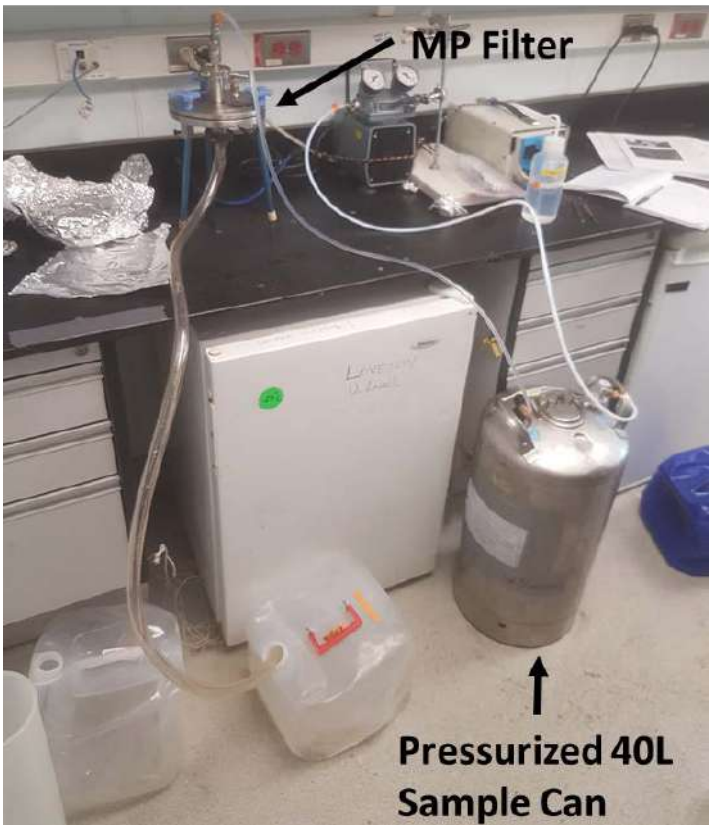

Figure 23-3 Microplastic filtration set-up

23.2.9 *Synopsys*

Table 27-3 Overview of sampling by the contaminants group in legs 2a and 3. high volume water sample (HV), microplastic sample (MP), sediment (Sed), zooplankton (Zoop), per-fluorinated compound water sample (PFC), organophosphate ester water sample (OPE)

Leg	Station	Date	Hv	Mp	Sed	River sed	Zoo	Pfc	Ope	Moor	Particle	Air
2a	731	08-jul	1					2	1			
2a	736						1	3 (1 blk)	1			
2a	689	11-jul	1				1	2	2 (1 blk)			
2a	341	12-jul					1		2			
3	312	19-aug	1		2		1					
3	Gjoa haven	20-aug		2								
3	Qmg1	21-aug	1		2		1					
3	Qmg2	21-aug			2		1	2	1			
3	Qmg4	22-aug		4 (2 blk)	2		1	3	2			
3	Qmg3	22-aug	1		2		1					
3	Qmgm	22-aug			2		1					
3	Prince regent inlet	25-aug	1									
3	322	26-aug	2 (1 blk)					2	1			
3	Site 1.1	27-aug		2	4 (2 blk)							
3	Trinity glacier	28-aug	1					2	1			
3	101	27-aug		2	2		1		1			
3	106	28-aug										
3	115		1		2		1	2				
3	Near qikiqtarjuak	31-aug	2 (1 blk)						1			
3	Ba05									1		
3	Ba06									1		
3	177						1	2				
3	Site 1.5 (coronation fjord)	31-aug			4 (2 blk)				1			
3	Sunneshine fjord	02-sep										
3	Underway	-				4					16 (1 blk)	15 (3 blk)

23.3 Preliminary Results

Samples will be analyzed at the Center for Atmospheric Research Experiments in Egbert, ON (ECCC facility) as well as the University of Toronto.

24 Microplastic Sampling – Leg 2c

Project leader: Sarah-Jeanne Royer[1] (sjroyer@hawaii.edu)
Cruise participant – Leg 2c: Gustavo Adolfo Guarin[2]
[1] *Scripps Institution of Oceanography, University of Hawaii, Honolulu, HI, United States*
[2] *Department of biology, Université Laval, Quebec City, QC, Canada*

24.1 Introduction

In the last decade, studies have proven the presence of microplastic debris (particles smaller than 5.0 mm in size) in aquatic ecosystems and organisms. Microplastic particles are a growing marine environmental problem that has the potential to negatively affect wildlife. Sediment, water and organism samples were collected between August 5th and August 13th, 2018 (Leg 2c), on board of the CCGS *Amundsen*, in order to gain a better understanding of the impacts of microplastics. Details about the sampling stations are reported in Table 25.1 and Figure 25.1.

24.2 Methodology

Surface sediment was collected with a metal spatula in the box-core; samples were frozen at -20°C. Water samples (50 ml samples) were collected in triplicate at different geographical locations with a bucket. Samples were stored and frozen in Falcon tubes at -20°C. Before the water sampling, the falcon tubes and the bucket were rinsed with milli-Q water three times to reduce potential contamination. Benthic organisms were collected with an Agassiz trawl and stored at -20°C for posterior analysis.

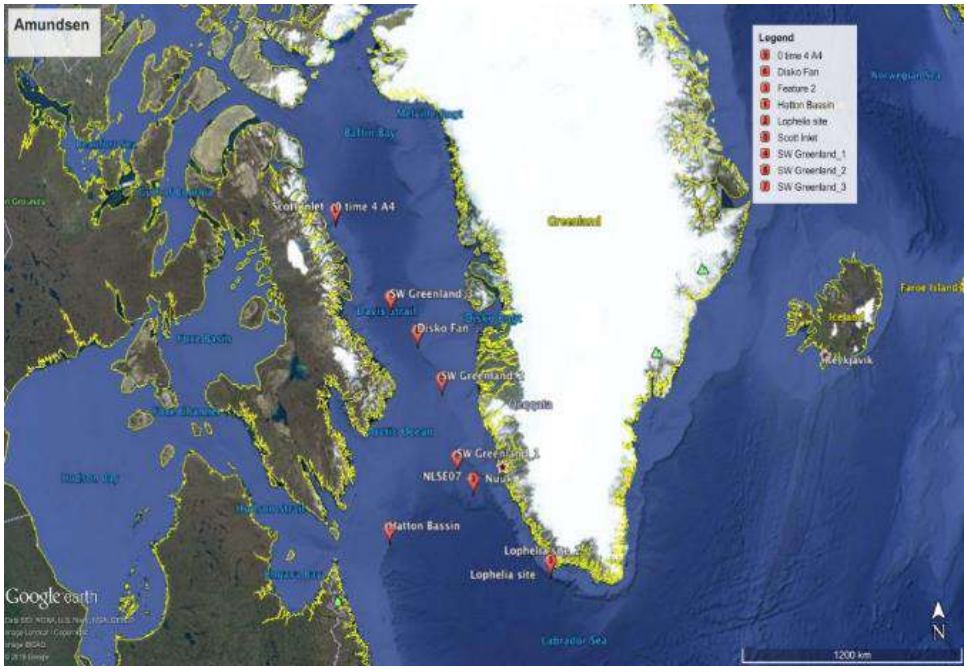

Figure 24-1 Sampling stations of water

Table 28-1 Station ID of the microplastic sampling, with date, geographic coordinates, location and type of samples collected for further analysis.

	Sample Id	Date	Local Time	Location	Sample Type	Latitude (N)	Longitude (W)
1	Hatton Bassin	05/082018	11:10	Southern Baffin Bay	Water	61.43727	- 60.66732
2	Lophelia site Greenland	06/08/2018	18:40	SW Greenland	Water	60.36968	- 48.46247
3	Lophelia site_2 Greenland	08/08/2018	10:5	SW Greenland	Water	60.36498	- 48.46957
4	NLSE07	09/08/2018	11:25	Baffin Bay	Water	63.2509	- 54.1989
5	SW Greenland_1	09/08/2018	10:51	Baffin Bay	Water	63.99804	- 55.50314
6	SW Greenland_2	10/08/2018	11:43	Baffin Bay	Water	66.49895	- 57.00849
7	Disko Fan	10/08/2018	22:15	Baffin Bay	Water	67.97867	- 59.51255
8	Disko Fan	11/08/2018	16:07	Baffin Bay	Sediment	67.96711	-59.49103
9	SW Greenland_3	11/08/2018	10:29	Baffin Bay	Water	68.97749	- 62.48307
10	Scott Inlet	12/08/2018	10:45	Baffin Island Coast	Water	71.38654	- 70.05215
11	Scott Inlet SW-1K_D	13/08/2018	13:34	Baffin Island Coast	Organism	71.37201	-70.09051
12	0 time 4 A4	13/08/2018	9:48	Baffin Island Coast	Water	71.37845	- 70.07475

25 Sampling Water for Pesticides Analysis in Arctic Waters - Leg 3

Project leaders: Johann Lavaud[1] (johann.Lavaud@bio.ulaval.ca) and Philippe Juneau[2]
Cruise participant – Leg 3: Disney Izquierdo[2]
[1]*Takuvik, Université Laval, Québec, QC, Canada*
[2]*Departement of Biological sciences, Université du Québec à Montréal, Montréal, QC, Canada*

25.1 Introduction

Due to the long distance aerial and marine transport of chemicals, Arctic waters are contaminated with pesticides applied in the southern parts of Canada, in the USA and EU countries (Hoferkamp et al., 2010; Macdonald et al., 2000; Muir and de Wit, 2010; NCP, 2013). More than 75% of the Arctic phytoplanktonic biomass is composed of diatoms and small flagellate prasinophytes (Micromonas sp.) (Balzano et al., 2012) resulting in their essential role for the Arctic food web (Jardillier et al., 2010). These phytoplankton support the growth of various zooplankton species (mainly copepods) (Bluhm et al., 2011; Kosobokova et al., 2011; Poulin et al., 2011), which are essential for fish. In temperate waters, pesticides impair physiology and growth of both phytoplankton and zooplankton (De Lorenzo et al., 2001; Relyea, 2005), but nothing is known about the potential impacts of pesticides on Arctic plankton. This lack of knowledge on the potential impacts of pesticides on Arctic organisms has a direct implication on the use of bioassay to detect water pollution in the Northern regions. Indeed, since the algal and zooplanktonic bioassays performed nowadays use temperate species, they might be not well suited to investigate contamination of Arctic waters.

25.1.1 *Objectives of the entire project*

1. Determine the abundance and concentration of 18 pesticides in Arctic marine waters at different locations of the Canadian Arctic.
2. Investigate the potential biological effects of environmentally relevant concentrations of pesticides (alone and mixed) found in Arctic marine waters on the major phytoplankton and zooplankton species.
3. Determine if Arctic phytoplankton and zooplankton show similar sensitivity to pesticides than their temperate counterparts (comparison for the same species), and if not, understand the physiological basis of the differential sensitivity.
4. Compare the sensitivity of Arctic phytoplankton and zooplankton to the temperate species typically used in standard laboratory toxicity tests, and determine toxicity reference values for the studied pesticides.

* Operations conducted on CCGS *Amundsen* during Leg 3 were oriented towards completing objective 1.

25.2 Methodology

Seawater was collected from the different sampling sites (Table 26.1). Water samples were pumped directly through a line from the front of the ship at a depth of 5m in 20L polypropylene and polycarbonate bottles. Water was then filtered through a series of 3 filters, 124mm glass fiber filter (Millipore, 2.0 µm), 142mm glass fiber filter (Whatman GF/F, 0.7µm) and 142mm Nitrocellulose membrane (Millipore, 0.22 µm), to remove suspended particulate matter. Extraction was done using SPE columns (Strata-X 33µm Polymeric Reverse Phase, 10g/60ml) through which 8-12L of the previously filtered water were processed (Table 26.1). Columns were stored at -20°C until analysis. Analysis will be done later at Université de Montréal.

Table 29-1 Seawater sampling sites and volumes collected

Sampling site	Station/Coordinates	Date	Sample volume (L)	Volume/Column (L)
1	QGM4	2018-08-21	120	12
2	73° 3.01601N, 89° 64.3298W;* 72° 34.4707N, 90° 15.2513W	2018-08-24	137.6	11.47
3	322	2018-08-26	137.8	11.48
4	115	2018-08-28	136	11.33
5	71° 2,3330N, 66° 22.6832W;* 70° 34.3847N, 66° 0.5113W	2018-08-30	140	11.67
6	1.5	2018-08-31	142.4	11.87
7	177	2018-09-01	137.2	11.43
8	66° 0.6334N, 61° 44.4154W (Sunshine fjord)	2018-09-02	139.8	11.65
9	58° 02.628N, 61° 09.348W;* 58° 01.401N, 61° 07.956W	2018-09-06	99.4	8.28

* These sampling sites were conducted while ship was in transit. The first coordinates correspond to the beginning of the sampling and the last to the position of the ship when the sampling ended.

25.3 Reference

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26 Ship Diesel Degradation by Marine Microorganisms under Arctic Conditions (GENICE) – Leg 3

Project leaders: Casey Hubert[1] (chubert@ucalgary.ca) and Charles W. Greer[2]
Cruise participant – Leg 3: Lars Schreiber[2]
[1] *Biological Sciences Department, University of Calgary, Calgary, AB, Canada*
[2] *Energy, Mining and Environment Research Center, National Research Council (NRC), Montreal, QC, Canada*

26.1 Introduction

As a consequence of global change, average yearly temperatures in the Canadian Arctic are increasing. These increasing temperatures result in decreased ice cover and, with it, increased suitability of Arctic waters for ship traffic. Increased ship traffic increases the probability of a spill of ship fuel and, in the case of oil tankers, of crude oil into Arctic waters.

In general, this project aims at increasing the preparedness for such petrol spill scenarios. More specifically, this project focuses on the petrol-degrading capability of microbial communities naturally present in Arctic marine waters and sediments. One main objectives of this project is to characterize pelagic and benthic microbial communities of the Canadian Arctic prior to a petrol spill (baseline), to later be able to identify the influence of spilled petrol on these communities. The second aim of this project is to quantify the rates of microbial petrol degradation under Arctic conditions and to identify factors that influence these rates. During this year's expedition of the CCGS *Amundsen* we focussed specifically on the degradation of ship Diesel.

26.2 Methodology

We collected surface water (in the context of this study defined as water from 0-5 m depth) samples by using Rosette-mounted Niskin bottles or by casting stainless steel buckets. Sampling locations were chosen to achieve the best possible coverage of the traversed Arctic waters. Microorganisms were extracted from the water samples by filtration and stored at -80°C for subsequent molecular biological analysis at the NRC labs in Montreal. Where possible, we also collected surface sediment samples from the sampling sites. To that end, sediment was collected by using a box core sampler. The upper ca. 1 cm of the box core was collected and stored at -80°C for subsequent molecular biological analysis at the NRC labs in Montreal. An overview of all acquired samples is shown Table 27.1.

In addition to collecting baseline samples, we set up microcosm incubations with surface water samples from the Gulf of Boothia (SAR site; approximate position: 69°48.5834'N, 91°8.3393'W), which were collected using bucket casts. Microcosms were set up with (1) ship Diesel and (2) ship Diesel in combination with the dispersant Corexit 9500 to characterize the corresponding Diesel degradation rates and microbial community changes. Microcosms were incubated in a controlled-temperature lab at 2-6°C for 10 days. Daily sub-samples were taken for subsequent flow-cytometric cell counting and microbial community analysis. Sub-samples were stored at -

80°C. Samples designated for flow cytometry were preserved with 1% formaldehyde (final concentration) and flash-frozen using liquid nitrogen prior to storage. The obtained sub-samples will be analyzed at the NRC labs in Montreal. After 10 days of incubation, microcosms were preserved by addition of dichloromethane (5% final concentration) for subsequent quantification of Diesel degradation rates (performed at University of Manitoba).

Table 30-1 Overview of samples taken for the GENICE project during Leg 3 of the 2018 Arctic expedition of the CCGS *Amundsen*

Location	Station	Lat (N)	Long(W)	Samples taken
Queen Maud Gulf	312	69°10.200'	100°42.000'	Seawater (Rosette, 5m); Marine sediment (box core, surface layer)
Queen Maud Gulf	QMG-1	68°29.400'	99°53.400'	Seawater (Rosette, 5m); Marine sediment (box core, surface layer)
Queen Maud Gulf	QMG-M	68°18.000'	101°44.400'	Seawater (Rosette, 5m); Marine sediment (box core, surface layer)
Queen Maud Gulf	QMG-4	68°28.800'	103°25.800'	Seawater (Rosette, 5m); Marine sediment (box core, surface layer)
SAR site in Gulf of Boothia	-	69°48.5834'	91°8.3393'	Seawater (bucket casts, surface)
Lancaster Sound	322	74°29.6554'	80°38.4740'	Seawater (Rosette, 5m)
Northern Baffin Bay	1.1	76°28.8249'	78°44.4043'	Seawater (bucket casts, surface); Marine sediment (box core, surface layer)
Northern Baffin Bay	115	76°19.800'	71°12.000'	Seawater (Rosette, 5m); Marine sediment (box core, surface layer)
Qik	Site 1.5 (Qik Bay)	67°25.985'	63°35.711'	Marine sediment (box core, surface layer)
Qik	177	67°28.800'	63°40.800'	Seawater (Rosette, 5m)

27 Contributions of Climate Change and Hydroelectric Regulation to the Variability and Change of Freshwater-Marine Coupling in the Hudson Bay System – Legs 1 and 2a

Project leaders: Fei Wang[1] (feiyue.wang@umanitoba.ca), Allison Zacharias[2] and Sarah Wakelin[2]
Cruise participants – leg 1: Kathleen Munson[1], James Singer[1], Zhiyuan Gao[1], Samantha Huyghe[1] and Ainsleigh Loria[1], Punarbasu Chaudhuri[1]
Cruise participants – Leg 2a: Kathleen Munson[1] and Ainsleigh Loria[1]
[1]*University of Manitoba, Winnipeg, MB, Canada*
[2]*Manitoba Hydro, Winnipeg, MB, Canada*

27.1 Introduction

27.1.1 *Water and Ice*

Mercury is a containment of global concern. Away from industrialized area, mercury is observed to accumulate through food webs in the Arctic marine ecosystem, which provokes concern from northern communities whose daily diet is heavily dependent on Arctic marine biota. The speciation of mercury determines its toxicity, the methylated species are known as a neurotoxin and can cause adverse effect on living organisms. On the other hand, dissolved organic matter (DOM) in the water column plays an important role in regulating mercury redox chemistry and mediating methylation/demethylation capability (Luo et al. 2017; Soerensen et al. 2017). However, the mechanism behind in the seawater is not well understood due to lack of structural and molecular information of marine DOM.

The Canadian Arctic is experiencing a period with extensive influence caused by climate change, which may greatly affect the fate of mercury (Stern et al. 2012). These changes include increased freshwater inputs and changing sea ice conditions.

The objective of this cruise is to build a mercury (total mercury and methylmercury) budget in Hudson Bay by seawater samples collected from the rosette, ice sampling, zodiac, barge and helicopter sampling for rivers and sediment core sampling. Selected water and ice samples will be analyzed for DOM characterization, which may assist in interpreting the fate of mercury in the Arctic. Incubation experiments were conducted using seawater samples from subsurface chlorophyll maximum, oxygen minimum and bottom, as well as in sediment cores to determine the net methylation capability in different Hudson Bay reservoirs to determine their impact on the mass budget of mercury.

27.1.2 *Sediment*

The objectives of the sediment collection were:

1) To revise and update the estimate of the total sediment sink for Hudson Bay in consideration of both oceanographic and geologic domains using a combination of geophysical and geochemical data;

2) To investigate the processes contributing to sedimentation patterns and rates using approximately monthly sediment trap samples spanning a year to document seasonal distribution of fluxes.

The samples collected on this cruise will go towards objective 1 and filling the gaps in the data from archived and previous published data. The cores are also being supplemented by subbottom data, collected on Leg 1, to compare the geophysical data from each coring location with the geochemical data that will be obtained from the cores.

27.1.3 *Mercury and Organic Contaminants Sampling and Deployments*

As the average global temperature increases, the sea ice cover in the Arctic is declining. With a reduced ice cover throughout the year, the amount of cargo traffic and oil exploration and exploitation throughout the Arctic is expected to increase, putting this pristine environment at a higher risk of cargo-related pollution.

As a part of Arctic Net and BaySys, our group aims to collect baseline contaminant data in a variety of media in the Arctic. More specifically, we collect biological samples (zooplankton and invertebrates) to determine mercury concentrations within the food web. This year, I also collected water samples and surface sediment (sediment collected by Diana Saltymakova and Teresinha Wolfe) for organic contaminants for Liisa Jantunen. Moreover, the deployment of organic contaminant passive samplers on moorings along the primary shipping route to Churchill will help us generate an idea of the existing organic contaminant concentrations within the Bay.

27.2 Methodology

27.2.1 *Water and Ice*

In order to assess the ability to collect contamination-free water samples during Leg 1, we cleaned the Amundsen rosette Niskin bottles in the rosette shack by soaking 0.1% citronax overnight in the bottle. We then rinsed then bottles several times. Random Niskin bottles were tested for contamination by adding reagent grade water (Milli Q) to the bottles and collecting blank tests after the allowing the MQ to sit in the bottle for an hour. Total mercury (THg) was analyzed from each bottle in the Portable In-Situ Laboratory for Mercury Speciation (PILMS). Every bottle tested was found to be clean (below detection limit defined as three times the standard deviation of reagent blank values) for THg analysis.

During the rosette sampling, the door to the rosette shack was closed all the time, both unfiltered and filtered seawater samples were collected from targeted depths, including 10 m, 20 m, 30 m, subsurface chlorophyll maximum, 50 m, 60 m, 80 m, 100 m, 140 m, 160 m, 200 m and bottom. Filtered samples were collected by directly attaching a capsule filter (0.45 µm, Acropak) to the Niskin spigot. Samples were collected in both 250mL amber glass bottles and 50 mL Falcon tubes. Amber glass bottles were preserved with 0.5% HCl and will be transported back to University of Manitoba for methylmercury and total mercury analysis. Samples collected in Falcon tubes were brominated (0.5 % BrCl) for 8 hours and analyzed onboard in PILMS for total

mercury analysis on a Tekran 2600 using manufacturer-based adaptations of standard protocols (EPA 1631). A full list of stations collected for mercury analysis is noted in Table 27.1 and Table 27.2.

Table 31-1 Amundsen 2018 Leg 1 rosette water sample collection (HgT: total mercury; MeHg: methylmercury)

Time	Station ID	Latitude	Longitude	Cast type	Depth (m)	deep bottle (m)	Samples collected
18:00:01 31/05/2018	N01 (356)	60.81326	-64.53336	Nutrients	328.75	378	HgT, MeHg
21:56:38 31/05/2018	N02 (354)	60.97350	-64.77335	Nutrients	571.13	555	HgT, MeHg
00:55:43 01/06/2018	N03 (352)	61.15020	-64.80869	Nutrients	430.12	408	HgT, MeHg
21:32:25 02/06/2018	05 (FB01)	64.28652	-78.23075	Nutrients	233.03	228	HgT, MeHg
03:27:11 03/06/2018	07 (FB02)	64.06526	-79.06239	Nutrients	270	259	HgT, MeHg
20:22:26 03/06/2018	09 (FB03)	63.72014	-79.92091	Chem	94.15	91	HgT, MeHg
18:57:02 04/06/2018	11	62.87649	-78.86373	Chem	315.56	300	HgT, MeHg
07:47:48 05/06/2018	12	63.39575	-81.22443	Nutrients	85.78	74	HgT, MeHg
17:40:55 05/06/2018	15	63.17518	-81.84978	Chem	189.97	179	HgT, MeHg
21:28:57 06/06/2018	16	62.28897	-85.85817	Chem	134.24	122	HgT, MeHg, DOM characterization
21:52:02 07/06/2018	17	63.18464	-90.03573	Bio-Chem	88.43	80	HgT, MeHg
08:34:38 08/06/2018	18	63.71367	-88.41683	Chem	115.61	104	HgT, MeHg
15:26:46 09/06/2018	19	61.84652	-92.13222	Chem	78.33	69	HgT, MeHg
17:40:14 10/06/2018	21	60.91036	-89.32936	Chem	149.3	135	HgT, MeHg
14:35:02 11/06/2018	22	60.42076	1000.65000	Chem	63.56	53	HgT, MeHg
22:43:44 12/06/2018	24	61.71082	-87.78786	Chem	188.81	177	HgT, MeHg, DOM characterization
01:19:37 15/06/2018	28	62.41552	-89.83392	Nuts-Chem	163.63	150	HgT, MeHg
13:05:13 16/06/2018	29	61.76978	-84.30910	Chem	176.99	164	HgT, MeHg
18:19:26 18/06/2018	31	57.50009	-91.79532	Nutrients	47.4	37	HgT, MeHg
19:26:14 19/06/2018	32	56.98203	-88.14683	Chem	35.03	24	HgT, MeHg, DOM characterization
01:09:36 21/06/2018	34	56.49983	-86.86875	Chem	43.78	33	HgT, MeHg, DOM characterization
02:42:34 22/06/2018	35	57.17978	-86.49995	Nutrients	61.46	51	HgT, MeHg, DOM characterization
15:19:45 22/06/2018	36	57.77413	-86.03131	Chem	128.34	116	HgT, MeHg, DOM characterization
03:07:08 23/06/2018	37	58.46892	-86.22553	Nutrients	169.68	157	HgT, MeHg, DOM characterization

19:17:04 23/06/2018	38	58.73043	-86.30196	Chem	180.99	168	HgT, MeHg, DOM characterization
18:47:11 24/06/2018	40	58.23979	-88.58159	Chem	87.07	75	HgT, MeHg, Methylation incubation
	43 (15 rep)			Chem	189.97	100	HgT, MeHg
	44			Chem		91	HgT, MeHg, DOM characterization
	45			Bio-Chem	18	10	HgT, MeHg, Methylation incubation

Table 31-2 Amundsen 2018 Leg 2a rosette water sample collection (HgT: total mercury; MeHg: methylmercury)

Time	Station ID	Latitude	Longitude	Depth (m)	deep bottle (m)	Samples collected
13:11 07/07/2018	731	55°24.480	77°55.678	124	118	HgT, MeHg
19:08 08/07/2018	730	56°11.057	76°43.398	138	129	HgT, MeHg
11:08 09/07/2018	736	58°25.384	78°18.743	99	87	HgT, MeHg,
23:01 11/07/2018	689	62°20.542	75°32.087	120	112	HgT, MeHg

In order to determine the magnitude of the sea ice mercury reservoir in Hudson Bay, ice cores were collected at selected ice stations and sectioned *in situ* on the ice floes. Cores were collected using a core barrel (9 cm ID, Kovac Mark II). In order to keep samples free of contamination, ice sections were trimmed using ceramic knife to remove the outer ice layer that came into contact with the core barrel. Trimmed sections were transported in double Ziploc bags and melted at room temperature in PILMS. Unfiltered ice melts were poured off for methylmercury and total mercury analysis and filtration (0.45 μm Pall filtere, Nalgene filter cups) under low pressure (~10 psi) using a vacuum pump in PILMS. Both filtered and unfiltered ice melts were preserved according to the same method as seawater samples. Ice interface waters and melt pond waters were collected in some stations. The details of ice samples are noted in Table 28.3.

Table 31-3 Stations sampled for ice (Leg 1)

Time	Station ID	Latitude	Longitude	Sampled by
	5			Helicopter
	9_H3			helicopter
18:44:48 06/06/2018	16	62.27823	-85.89189	Ice cage
20:10:02 08/06/2018	18	63.72603	-88.32335	Ice cage
14:36:36 13/06/2018	25	61.99977	-86.97196	Ice cage
18:27:09 23/06/2018	38	58.72937	-86.30572	Ice cage

Additional samples were collected from surface waters during helicopter and zodiac deployments to ice and open water stations. Because the upper water is both subject to mixing

and mercury contamination from the ship, surface (< 10 m) samples cannot be collected from the rosette. Instead, surface water, including interface water under ice floes, was collected using a battery powered submersible cyclone pump (Proactiv, 12V). The pump and tubing were tested for total mercury contamination prior to sample collection and compared to values obtained using a Go-Flo bottle. For each station, blanks were collected on site to test sampling environment.

Table 31-4 River estuary sampling by Barge and Zodiac

Date	Time (UTC)	Name	Latitude	Longitude
2018-06-7?	After visit hydr	River 1 ice edge (chesterfield inlet) St17	63.3738	-90.630833
2018-06-7	After visit hydr	River 1 intermediate St17	63.285	-90.353333
2018-06-7	After visit hydr	River 1 rosette St17	61.191666	-90.541666
2018-06-8	19:29	St18 skippy	63.7313862	-88.3224324
2018-06-10	19:39	St19	61.9570016	-92.2719114
2018-06-11	17:17	St22 estuary	60.479666	-94.563833
2018-06-11	18:15	St22 intermediate	60.475833	-94.527683
2018-06-11	18:53	St22 rosette	60.446666	-94.005
2018-06-19	17:10	St32 Rosette open water near dirty ice	56.9866728	-88.1352983
2018-06-19	16:40	St 32 Under dirty ice	56.9839734	-88.120189
2018-06-20	18:20	St34 5m from ice	56.506166	-90.883166
2018-06-20	19:12	St34 open water area	56.496266	-86.878433
2018-06-29	Afternoon	Nelson southern transect st1	57.1842333	-91.81105
2018-06-29	Afternoon	Nelson southern transect st2	57.2081	-91.8711
2018-06-29	14:20	Nelson 1(barge)	57.0533682	-92.5321723
2018-06-29	18:50	Nelson 2 (barge)	Greg, gps not on cw	
2018-06-30	14:21	Nelson water 3	57.2059296	-92.2824796
2018-06-30	19:48	Nelson water 4	57.22215	-92.29395

In order to determine the magnitude of the riverine mercury and methylmercury inputs into Hudson Bay, surface water samples were collected from rivers reached by helicopter at stations targeting freshwater (salinity = 0). River water was collected using a submersible pump (Proactiv, 12V) attached to an extendable painters pole the end of which was kept afloat with an empty 4L plastic acid bottle to keep the pump near the water surface. Filtered and unfiltered water samples were collected from the pump.

Table 31-5 River sampling by helicopter (Leg 1)

Date	Time (UTC)	Name	Latitude	Longitude

2018-06-10	14:08	Thlewiaza River	60.4851	-94.8167
2018-06-10	13:15	Tha-anne River	60.5461	-94.8292
2018-06-18	18:55	Nelson River	56.9659	-92.6305
2018-06-18	20:50	Hayes River	56.9955	-92.2924
2018-06-19	18:42	Severn River	55.9603	-87.7081
2018-06-20	17:15	Winisk River	55.2275	-85.2114
2018-06-28	19:08	Seal River	59.0739	-94.8425
2018-06-28	20:06	Knife River	58.8831	-94.7031
2018-06-28	20:42	Churchill River	58.6781	-94.2033

Table 31-6 River sampling by helicopter (Leg 2)

Time	River	Latitude	Longitude	Flow	Turbid?	Samples collected
18:30 10/07/2018	Rivière Puvirnituq	60°04'21"	77°14'49"	High	No	HgT, MeHg
18:45 11/07/2018	Rivière Foucault	62°06'29"	75°45'30"	Moderate	No	HgT, MeHg
20:15 11/07/2018	Rivière Deception	62°05'51"	74°29'44"	High	No	HgT, MeHg

In selected stations, water and ice samples were collected for the purpose of DOM characterization. For the rosette sampling, targeted depth included 10 m, subsurface chlorophyll maximum and bottom. Ice cores were sectioned into a size of 10 to 15 cm from top, middle and bottom part. Only filtered water samples were used for DOM, it can be either capsule filter directly from the Niskin bottle or filtration using vacuum pump. For both seawater samples and ice melts collected for DOM, 200 mL was stored in an amber glass bottle in the chest freezer, and up to 500 mL was loaded through a solid phase extraction (SPE) setup using Bond Elut PPL cartridges from Agilent. The volume of ice melts loaded on the cartridges varied depending on the size of the ice section. The loaded cartridges were stored in Ziploc bags separately and in the freezer until further treatment.

27.2.2 *Sediment*

Sediment sampling

A box corer was used to collect sediment cores at basic and full stations where there were not too many rocks (the Agassiz trawl was used to assess the presence of large rocks that could damage the box corer). The box corer was deployed using the a-frame and winch on the port side of the ship. If the bottom of the box corer was sealed and the sediment inside was not slumped, a core tube was then pressed into the sediment. The sediment core was then taken to the lab on board the ship, measured, and sectioned into whirlpacks in intervals of 1 cm until 10 cm, 2 cm until 20 cm, and 5 cm after 20 cm. There were a couple of exceptions to these intervals in the cases of cores (Stations 17, 18, and 19) where there were still visible colour or textural changes past 20 cm. In these cases, the cores were sectioned 1 cm until 10 cm and 2

cm after 20 cm for higher resolution during analysis. The whirlpacks were then placed into a refrigerator and sent to the University of Manitoba for radioisotope, contaminants, and organic matter analyses.

Table 31-7 Locations and dates of the cores taken on Leg 1 of the 2018 Amundsen cruise.

Station Number	Date	Time (UTC)	Latitude	Longitude	Depth (m)
10	04-Jun-18	5:32:39	63.45071	-79.4452	202.73
17	08-Jun-18	0:08:20	63.18458	-90.0337	91.62
18	08-Jun-18	6:10:20	63.71968	-88.4021	122.15
19	09-Jun-18	17:21:36	61.84316	-92.1328	86.18
21	10-Jun-18	21:08:18	60.91407	-89.3385	148.93
24	13-Jun-18	0:04:24	61.70548	-87.7845	N/A
28	15-Jun-18	4:10:07	62.41676	-89.8175	161.79
29	16-Jun-18	9:58:48	61.74867	-84.2958	177.46
32	19-Jun-18	21:01:05	56.97127	-88.1301	33.6
36	22-Jun-18	20:16:31	57.77581	-86.0279	127.07
38	23-Jun-18	23:21:16	58.72343	-86.2957	179.9
40	24-Jun-18	19:52:17	58.24775	-88.5965	90.08

Water Filtration

At stations near and in the Nelson River estuary, a water filtration system was run to collect suspended sediment. The filtration system was run using a pump on the ship allowing the system to draw seawater from the ship's plumbing for the duration of the station. At the end of the station the filters were removed, refrigerated, and then sent back to the University of Manitoba for further analysis.

Table 31-8 The location and duration of each filtration for suspended sediment. (Leg 1)

Station Number	Date	Latitude	Longitude	Duration of Filtering
40	24-Jun-18	58.24337	-88.589	8 hrs, 50 min
45	29-Jun-18	57.25124	-91.9629	7 hrs, 55 min
45	30-Jun-18	57.22999	-91.9536	11 hrs, 5 min
46	01-Jul-18	57.39829	-92.0727	7 hrs, 40 min

27.2.3 *Mercury and Organic Contaminants Sampling and Deployments*

On board the CCGS *Amundsen*, we collected zooplankton alongside the Fortier group with the Tucker (1 m^2 750 µm mesh) and the Monster (1 m^2 200 µm mesh) nets.

Benthic invertebrate samples were also collected using the Beam Trawl and the Agassiz trawl. The samples from the Agassiz trawl were collected and identified by Marie Pierrejean.

Water samples for organic contaminants were collected from the rosette. 4 liters of surface water was collected for OPEs on the west/mid Hudson Bay, while 1 liter water samples were collected at the surface, above the thermocline and below the thermocline at passive sampler mooring sites for PFC analysis.

Organic contaminant passive samplers were deployed on moorings at 3 sites along the primary shipping route in Hudson Bay.

The following tables summarize the samples collected and the deployments that occurred related to contaminants during Leg 1 of the 2018 Amundsen cruise.

Table 31-9 Zooplankton samples collected during the BaySys 2018 cruise

Station	Tow	Bottom Depth (m)	Sampler Depth (m)	Species
04	Vertical	287	276	Calanus sp., Chaetognata, Climone limacina (2 cm), Hydromedusae, Bulk
05	Vertical	220	212	Calanus hyperboreus CV adult female, Ctenophora, Hydromedusae, Chaetognata, Bulk
09	Vertical	104	94	Chaetognata, Ctenophora, Bulk
09	Oblique	106	80	Chaetognata, Clione limacina (3.0-3.5 cm), Ctenophora, Bulk
10	Oblique	196	92	Calanus hyperboreus CV adult female, Clione limacina (5 cm), Ctenophora, Hydromedusae, Thysanoessa sp., Bulk
10	Vertical	199	189	Chaetognata, Themisto libellula (2.5-3.0 cm), Thysanoessa sp., Bulk
11	Vertical	320	310	Calanus hyperboreus CV adult female, Chaetognata, Ctenophora, Hydromedusae, Themisto libellula (2.5-3.0 cm, 3.5-4.0 cm), Thysanoessa sp., Bulk
15	Oblique	190	90	Ctenophora, Hyperoche medusarum, Themisto libellula (1.5-2.0 cm), Bulk
15	Vertical	191	181	Chaetognata, Ctenophora, Thysanoessa sp., Bulk
16	Oblique	135	95	Calanus hyperboreus CV adult female, Chaetognata, Ctenophora, Themisto libellula (2.0-2.5 cm), Bulk
16	Vertical	135	125	Calanus hyperboreus CV adult female, Chaetognata, Clione limacina, Bulk
17	Vertical	94	84	Chaetognata, Themisto libellula (2.0 cm), Bulk
18	Oblique	112	88	Chaetognata, Clione limacina (4.0-4.5 cm), Ctenophora, Themisto libellula (2.0-2.5 cm, 2.5-3.0 cm, 3.0-3.5 cm), Thysanoessa sp., Bulk
18	Vertical	115	105	Chaetognata, Clione limacina (4.0-4.5 cm), Ctenophora, Bulk
19	Vertical	76	66	Chaetognata, Bulk
19	Oblique	77	60	Chaetognata, Clione limacina (3.0 cm), Ctenophora, Themisto libellula (0.5-1.0 cm), Thysanoessa sp., Bulk
21	Vertical	163	133	Bulk
21	Oblique	147	92	Chaetognata, Ctenophora, Themisto libellula (0.5-1.0 cm, 2.5-3.0 cm, 3.0-3.5 cm), Bulk
22	Oblique	61	45	Clione limacina (2 cm), Ctenophora, Limacina helicina, Themisto libellula (0.0-0.5 cm, 0.5-1.0 cm, 1.0-1.5 cm, 1.5-2.0 cm), Bulk
22	Vertical	58	48	Bulk
24	Vertical	187	177	Calanus hyperboreus CV adult female, Chaetognata, Themisto libellula (2.5-3.0 cm), Thysanoessa sp., Bulk
25	Oblique	148	95	Calanus hyperboreus CV adult female, Chaetognata, Ctenophora, Clione limacina (2.0 cm, 4.0 cm), Bulk
25	Vertical	148	138	Calanus hyperboreus CV adult female, Chaetognata, Themisto libellula (2.5-3.0 cm), Thysanoessa sp., Bulk
28	Oblique	161	89	Chaetognata, Ctenophora, Themisto libellula (2.0-2.5 cm, 2.5-3.0 cm, 3.0-3.5 cm, 3.5-4.0 cm), Bulk
28	Vertical	161	89	Chaetognata, Thysanoessa sp., Bulk
29	Vertical	178	168	Calanus hyperboreus CV adult female, Chaetognata, Themisto libellula (1.5-2.0 cm, 2.0-2.5 cm, 2.5-3.0 cm), Bulk

29	Oblique	177	98	Calanus hyperboreus CV adult female, Chaetognata, Ctenophora, Themisto libellula (1.5-2.0 cm, 2.0-2.5 cm, 2.5-3.0 cm), Bulk
32	Vertical	32	22	Bulk
34	Oblique	44	34	Chaetognata, Hyperia galba, Bulk
34	Vertical	44	34	Bulk
36	Vertical	127	117	Chaetognata, Limacina helicina, Bulk
38	Oblique	178	75	Chaetognata, Ctenophora, Themisto libellula (2.5-3.0 cm, 3.5-4.0 cm), Bulk
38	Vertical	178	168	Chaetognata, Hydromedusae, Limacina helicina, Bulk
40	Vertical	86	76	Chaetognata, Bulk
43	Vertical	190	180	Chaetognata, Limacina helicina, Themisto libellula (0.5-1.0 cm, 2.0-2.5 cm, 2.5-3.0 cm), Thysanoessa sp., Bulk
43	Oblique	191	92	Chaetognata, Ctenophora, Limacina helicina, Themisto libellula (0.5-1.0 cm, 1.0-1.5 cm, 1.5-2.0 cm, 2.0-2.5 cm, 2.5-3.0 cm), Bulk
44	Oblique	106	90	Chaetognata, Hyperia galba, Limacina helicina, Themisto libellula (0.5-1.0 cm, 1.0-1.5 cm, 3.0-3.5 cm), Bulk
BN5	Reverse	14	10	Mysis sp.
45	Oblique	44	31	Bulk
45	Vertical	44	34	Bulk

Table 31-10 Benthic invertebrate samples collected during the BaySys 2018 cruise (Leg 1)

Station	Trawl	Depth	Species
04	Agassiz	274	Eualus gaimardii gaimardii, Gorgonocephalus sp.
09	Agassiz	237	Crossaster papposus, Rossia sp.
09	Beam Trawl	218	Anonyx sp., Argis dentata, Eualus gaimardii gaimardii, Henricia sp., Pandalus borealis, Rossia sp., Sclerocrangon boreas, Strongylocentrotus droebachiensis
15	Agassiz	189	Strongylocentrotus droebachiensis
15	Beam Trawl	200	Sclerocrangon boreas
16	Beam Trawl	135	Heliometra glacialis, Ophiacantha bidentata, Sclerocrangon boreas
17	Agassiz	94	Gorgonocephalus arcticus, Pandalus borealis
18	Beam Trawl	114	Argis dentata, Eualus gaimardii gaimardii, Heliometra glacialis, Ophiacantha bidentata
19	Agassiz	83	Argis dentata, Hyas coarctatus, Poraniomorpha sp., Strongylocentrotus droebachiensis
21	Agassiz	152	Ctenodiscus crispatus
21	Beam Trawl	152	Argis dentata
22	Agassiz	63	Chlamys islandica, Hyas coarctatus, Strongylocentrotus droebachiensis
25	Agassiz	145	Ophiura sp., Strongylocentrotus droebachiensis
28	Agassiz	162	Argis dentata, Sabinea septemcarinata, Spirotocaris intermedia
29	Agassiz	180	Ophiura sarsii
32	Agassiz	32	Strongylocentrotus droebachiensis
38	Agassiz	180	Ophiura sarsii, Pontaster tenuispinus
43	Beam Trawl	193	Argis dentata, Eualus gaimardii belcheri, Spirotocaris sp.
44	Agassiz	104	Argis dentata, Crossaster sp., Sabinea septemcarinata, Strongylocentrotus droebachiensis

Table 31-11 Water samples collected during the BaySys 2018 cruise (Leg 1)

Sampling Variable	Station	Station Depth (m)	Sampling Depth	Water T (°C)	Salinity
PFCs	15	189	Surface	-0.9931	32.2388
			30 m	-1.1237	32.3298

			140 m	-1.6181	32.6255
PFCs	29	175	Surface	-1.5223	30.7520
			20 m	-1.5437	30.7590
			50 m	-1.4613	31.6827
PFCs	44	98	Surface	1.4835	29.9287
			10 m	1.6668	30.6000
			40 m	-1.6588	32.6680
OPEs	22	63	Surface	0.9763	32.2266
OPEs	26	129	Surface	1.2516	31.7071
OPEs	31	46	Surface	1.4007	28.5423
OPEs	38	177	Surface	-1.3730	31.7004

Table 31-12 Sediment samples collected during the BaySys 2018 cruise (Leg 1)

Station	Date	Depth	End Latitude (N)	End Longitude (W)	Section
10	04-Jun-18	203	63.45098	79.44622	Surface
11	04-Jun-18	319	62.87041	78.85538	Surface
15	05-Jun-18	190	63.18558	81.86553	Surface
17	08-Jun-18	92	63.18437	90.03285	Surface
18	08-Jun-18	122	63.7196	88.40239	Surface
19	09-Jun-18	88	61.84331	92.13279	Surface
21	10-Jun-18	150	60.91368	89.33957	Surface
24	13-Jun-18	189	61.70507	87.78463	Surface
29	16-Jun-18	179	61.74696	84.29496	Surface
36	22-Jun-18	127	57.77598	86.02764	Surface
38	23-Jun-18	180	58.72420	86.29730	Surface

Table 31-13 Organic contaminant passive samplers deployed during the BaySys 2018 cruise (Leg 1)

Name	Cage Style	Station	Date	Station depth (m)	Cage depth (m)
Hudson Bay 1	Large stainless steel	15 Mooring 1	05-Jun-18	195	60
Hudson Bay 2	Small plastic/aluminum	29	16-Jun-18	179	40
Hudson Bay 3	Large stainless steel	44 CMO01	28-Jun-18	105	62

27.3 Reference

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28 Agassiz Trawl, Box Core and Rosette Sampling for HBI and Stable Isotope Analysis– Leg 2c

Cruise participants – Leg 2c: Gustavo Adolfo Guarin[1], Camilla Parzanini[2], Alec Aitken[3], Meghan Hamp[3], Vonda Wareham Hayes[4], Barbara de Moura Neves[4] and Catherine Young[5].
[1]*Department of biology, Université Laval, Quebec City, QB,*
[2]*Department of Ocean Sciences, Memorial University of Newfoundland, St. John's, NL*
[3]*Department of Biology, University of Saskachewan, Saskatoon, SK*
[4] *Fisheries and Ocean Canada, St. John's, NL*
[5]*Department of Environmental Science, Memorial University of Newfoundland, St. John's, NL*

28.1 Introduction

Polar regions are being increasingly affected by a series of disturbances linked to climate change. These alterations are more evident and intense in the Arctic Ocean, where the physical environment and the ecosystem structure and functioning are impacted. The reduction of thickness and extent of sea ice is a factor that especially concerns the scientific community because the sea ice influences the timing, quantity and spatial distribution of the Arctic primary production. The quantity and quality of primary production (rich in carbon) that reach the seabed have such a strong impact on the benthic communities, that any changes in carbon input are likely to affect species interactions, biodiversity, carbon sequestration, trophic transfer efficiency, food web structure and their resilience. In order to investigate how the benthic food web and organisms respond to changes in sea-ice cover and carbon input and how these changes could affect the Arctic benthic community and their resilience; epibenthic organisms were collected between July 25th to August 12th, 2018 (Leg 2c), on board of the CCGS *Amundsen*. Details about the sampling stations are reported in Table 38.1.

28.1 Methodology

Agassiz trawl (Figure 38.1) was deployed to collect mega- and macroepibenthic fauna at 2 stations (Table 38.1). Organisms were identified to the lowest possible taxonomic level and frozen at -20°C for compound specific isotope analysis (Figure 38.2). At 9 different stations (Table 38.2, Figure 38.3), water samples (10 m above bottom and chlorophyll maximum) were taken from the CTD Rosette, filtered on GF/F filters and kept at -20°C for particulate organic matter compound specific isotope analysis. From 07 box cores, surface sediments 10-15 cm in depth were collected for further analysis (Table 38.3). Sediment samples for pigment analysis were frozen at -80°C. Sediment samples for particular organic matter, granulometry, stable isotope, and HBI analysis were frozen at -20°C.

Table 32-1 Station ID of the Agassiz trawl sampling, together with the date, geographic coordinates, biomass, number and type of samples collected for further analysis.

Stn	Date	Position Start		Position End		Number	biomass (g)	Cod	Sample collected
		Latitude	Longitude	Latitude	Longitude				
DFO-750	31-Jul-18	60.45641	-61.2238	60.48107	-61.20946				
						10	<1	□	Pycnogonida spp.
						1		*□	*Heliometra glacialis* (crinoid)
						Fragment	80	*□	*Paramuricea* sp.
						3	8	□	*Buccinum* spp. (gastropods)
						pc	64	*□◊	sponge 1
						pcs	57	*□◊	sponge 2
						pcs	23	*□◊	sponge 3
						1	<1		sponge 4
						1		*□	spiny pink brittle star
						6	<1	*□◊	*Lycopodina c.f. lycopodium*
						1		*□	crinoid+brittle star
						6	6	□ ▶	Polychaeta spp.
						2	<1	□ ▶	*Henricia* sp?
						2		*□	tubes of Hydrozoa spp.
						1		□	Ophiuroidea 2
							209	*●◊	*Asconema* sp
							52	*●	*Mycale mycale lingua*
							23	*●	Polymastidae
							<1	*	*Primnua resedaeformis*
						1	47	▶	*Lithodes maja*
						1	307	▶	*Actinostela sp.*
						1	<1	▶	*Halipteris finmarchia*
						1 pcs	<1		*Paragorgia arborea*

						6	23	►	Lantern fish
						15	5	►	*Anthomastus agaricus* ?
						3	6	►	*Ophiacantha* sp
						1	18	►	*Heliometra glacialis*
						2	6	►	*Leptychaster articus*
						1	<1		Zoanthid sp
						10	<1	►	*boreonymphon* sp.
						10	<1	►	*Pycnogonida* sp.2
						2	17	*	Duva florida
						11	1	►	Arrow worms
						1	3		Skate egg case (empty)
						Colony	40	□	Hydroid
						1	<1		*Colus* sp1 (empty)
						1	<1		Colus sp2
						3	4	►	*Astarte* sp
						15	12	►	*Hymenodora glacialis*
						27	11	►	*Boremysis* sp.
						2	<1	►	*Epimeria loricata*
						1	<1	◊	Clavularidae
						104	12	►	*Ophiuroidea* spp.
						pcs	4	◊	Bryozoans spp
							96	*	Porifera (scraps of many species)
						3	<1	◊	sponge 5
						3	<1		Copepoda
						1	<1	►	*N. abysorum*
						1	<1	►	Isopoda
		71.37201	-70.0905	71.37355	-70.0673				

Scott Inlet SW-1K_D	12-Aug-18								
						1	35	►	*Heliometra glacialis*
						40	73	►	*Eualus galmardii belcheri*
						5 fragments	4	*	*Paramuricea sp.*
						1	15	►	*Anisarchus medius*
						1	<1	►	*Cliona sp.*
						1	6	►	*Ophiopleura borealis*
						1	<1	►	*Lebbeus groenlandicus*
						1	<1	►	Polar scupin
						1	<1	*	*Ctenophora* sp.
						1	<1	►	Amphipoda sp
						1	<1	►	Polychaeta sp.1
						1	<1	►	Onuphidae

* Samples taken end/or subsampled by Catie Young, Memorial University of Newfoundland for stable isotopes and identification.
● Samples subsampled for ATLAS by Catie Young, Memorial University of Newfoundland for stable isotopes and transcriptomics.
□ Samples taken end/or subsampled by Camilla Parzanin, Memorial University of Newfoundland, preserved and stored in ethanol 70%.
► Samples taken end/or subsampled by Gustavo Guarin, Laval University, for stable isotopes and identification.
◊ Subsamples taken by DFO NL.

Figure 28-1 Agassiz trawl used to catch epibenthic organisms on board of the CCGS *Amundsen*

Figure 28-2 Example of mega- and macroepibenthic fauna cached by the Agassiz trawl. Station DFO-750 ((left), and station Scott Inlet SW-1K_D (right).

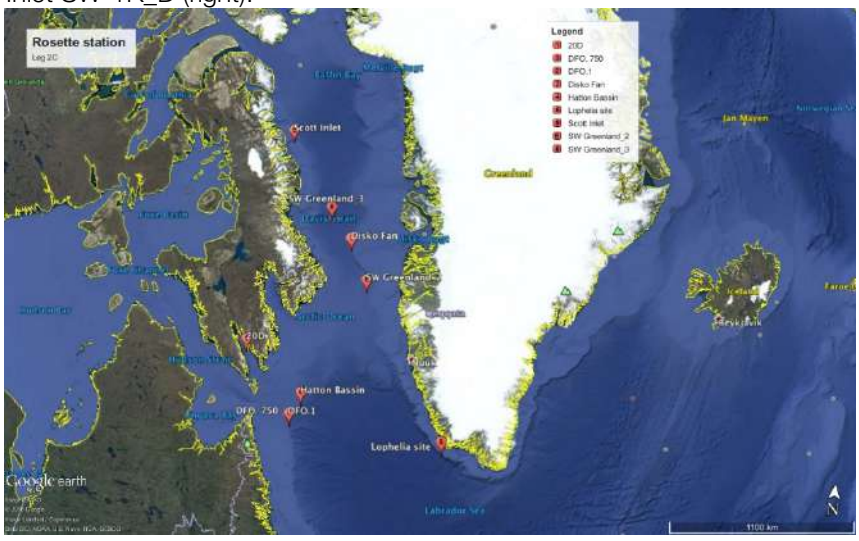

Figure 28-3 Sampling stations of water (bottom and chlorophyll maximum) for further stable isotope analysis.

Table 32-2 Station ID of the CTD Rosette sampling collected for further stable isotope analysis

Sample	Date	Local time	Location	Depth (m)	Latitude (N)	Longitude (W)
20D	26/07/2018	12:48	Frobisher bay	141	62.84429	-66.59396
Saglek bank DFO. 1	29/07/2018	16:50	Southern Baffin Bay	506.5	60.45298	-61.25635
DFO. 750	31/07/2018	11:37	Southern Baffin Bay	744.11	60.46723	-61.21773
Hatton Bassin	05/082018	11:10	Southern Baffin Bay	621	61.43727	- 60.66732
Lophelia site Greenland	06/08/2018	18:40	SW Greenland	700	60.36968	- 48.46247
SW Greenland_2	10/08/2018	11:43	Baffin Bay	667.45	66.49895	- 57.00849
Disko Fan	10/08/2018	22:15	Baffin Bay	910.6	67.97867	- 59.51255
SW Greenland_3	11/08/2018	14:14	Baffin Island Coast	1892	68.97749	-62.48307
Scott Inlet Rosette 2	12/08/2018	13:34	Baffin Island Coast	259.95	71.37635	-70.07686

Table 32-3 Station ID of the box-core sediment sampling collected for further stable isotope analysis

Sample	Date	Local time	Location	Depth (m)	Latitude (N)	Longitude (W)
11C	25/07/2018	19:41	Frobisher bay	373.42	63.1651	-67.5518
20D	26/07/2018	13:59	Frobisher bay	107.58	62.84466	-66.58861
DFO_03	31/07/2018	04:21	Southern Baffin Bay	1160.04	60.46929	-61.09412
DFO_05	02/08/2018	10:17	Southern Baffin Bay	1424	60.46942	-60.58832
DFO_07	03/08/2018	00:34	Southern Baffin Bay	1899	60.47592	-60.38135
DFO_08	03/08/2018	16:53	Southern Baffin Bay	2445	60.46749	-59.24414
Disko Fan	11/08/2018	4:07	Baffin Bay	882	67.96711	-59.49103

29 Benthic Biodiversity, Biological Productivity and Biogeochemistry in the Changing Canadian Arctic – Leg 3

Project leader: Philippe Archambault[1] (philippe.archambault@bio.ulaval.ca)
Cruise participants – Leg 3: Philippe-Olivier Dumais[1] and Cindy Grant[1]
[1] *Laboratoire d'écologie benthique, Université Laval, Québec, QC, Canada*

29.1 Introduction

In benthic ecosystems, the availability and quantity of food and the type of bottom influence the distribution, the abundance and the richness of benthic organisms. Generally, the rocky bottom presents a diverse assemblage of organisms (Posey and Ambrose 1994) whereas the soft bottom is more homogenous and the presence of organisms will depend of the grain size or of the availability of food. These types of bottom create heterogeneity and can be responsible of great concentrations of organisms and of the presence of the one species.

Our main sampling objective for the 2018 expedition is to advance biodiversity surveys of benthic communities with respect to the physical and chemical environment.

Our second objective is to investigate how the benthic food web and organisms respond to changes in sea-ice cover and carbon input and how these changes could affect the Arctic benthic community and their resilience (G. Guarin PhD thesis).

Finally, our third objective is to gain a better understanding of the impacts of microplastics. In the last decade, studies have proven the presence of microplastic debris (particles smaller than 5.0 mm in size) in aquatic ecosystems and organisms. Microplastic particles are a growing marine environmental problem that has the potential to negatively affect wildlife. Samples were collected for Sarah-Jeanne Royer (International Pacific Research Center, University of Hawaii, sjroyer@hawaii.edu) and Dimitri Deheyn (Scripps Institution of Oceanography, University of California, ddeheyn@ucsd.edu).

29.2 Methodology

The box core was deployed to quantitatively sample diversity, abundance and biomass of endobenthic fauna and to obtain sediment cores for sediment analyses. From 9 box cores, sediments of usually a surface area of 0.125 m^2 and 10-15 cm in depth were collected and passed through a 0.5 mm mesh sieve and preserved in a 4 % formaldehyde solution for further identification in the laboratory (Table 39.1). Sub-cores of sediments were collected for sediment pigment content (top 1 cm), organic carbon content (top 1 cm), sediment grain size (top 5 cm) and stable isotope & HBI analysis (surface sediments). Samples for sediment pigment were frozen at -80°C, and all other sediment samples were frozen at -20°C. All samples will be transported off the ship for analyses in the lab at Université Laval.

At 9 stations, an Agassiz trawl (1.5 m width × 0.7 m height, cod end of 0.5 cm mesh size) was towed on the seabed at a speed of 1.5-2 knots for 3 minutes to survey epibenthic species diversity, abundance, and biomass (Table 39.2). Catches were passed through a 2 mm mesh sieve. Specimens were identified to the lowest taxonomic level, then counted and weighted. The unidentified specimens were preserved in a 4% seawater-formalin solution for further identification in laboratory. At specific stations, organisms were frozen at -20°C for compound specific isotope analysis. At those stations (Table 39.3), water samples (10 m above bottom and chlorophyll maximum) were taken from the CTD Rosette, filtered on GF/F filters and kept at -20°C for particulate organic matter compound specific isotope analysis.

Microplastics specific project

Surface sediment was collected with a metal spatula in the box core. Samples were frozen at -20°C. Surface water samples (50 ml samples) were collected in triplicate with a metal bucket. Samples were stored and frozen in Falcon tubes at -20°C. Before the water sampling, the falcon tubes and the bucket were rinsed with milli-Q water three times to reduce potential contamination. A tap water was collected at each station, using the same bucket as a control. Benthic organisms were collected with an Agassiz trawl and stored at -20°C for posterior analysis.

Table 33-1 Sampled variables during Leg 3 (Amundsen 2018) using the box core

Station	Date	Latitude	Longitude	Depth	Divesity	Grain size	Organic content	Pigments	Isotopes & HBI	Microplastics
312	19/08/2018	69.17015	-100.69963	67 m	1	1	3	3	1	1
QMG1	21/08/2018	68.49013	-99.88741	39 m	1	1	3	3	1	1
QMG2	21/08/2018	68.30988	-100.79994	73 m	1	1	3	3	0	0
QMG4	22/08/2018	68.48072	-103.42633	70 m	1	1	3	3	1	1
QMG3	22/08/2018	68.32988	-102.94164	51 m	1	1	3	3	0	0
QMGM	22/08/2018	68.29975	-101.74128	112 m	1	1	3	3	1	1
Site 1.1 (Manson)	27/08/2018	76.48059	-78.74047	124 m	1	1	3	3	0	1
101	28/08/2018	76.38251	-77.40990	373 m	1	1	3	3	1	1
115	29/08/2018	76.33157	-71.17621	662 m	1	1	3	3	1	1

Table 33-2 Agassiz trawl stations during Leg 3 (Amundsen 2018).

Station	Date	Start			End			Duration
		Latitude	Longitude	Depth	Latitude	Longitude	Depth	
312	19/08/2018	69.17233	-100.69647	68 m	69.17843	-100.69346	66 m	3 min
QMG1	21/08/2018	68.49128	-100.65000	34 m	68.48426	-99.89454	49 m	3 min
QMG2	21/08/2018	68.30935	-100.79838	62 m	68.30984	-100.79046	69 m	3 min
QMG4	22/08/2018	68.47864	-103.43332	68 m	68.47602	-103.42717	67 m	3 min
QMG3	22/08/2018	68.32972	-102.94163	51 m	68.32627	-102.93682	54 m	3 min
QMGM	22/08/2018	68.29971	-101.73909	112 m	68.29665	-101.72391	111 m	3 min
101	28/08/2018	76.37950	-77.39298	362 m	76.39218	-77.40338	340 m	3 min
115	29/08/2018	76.33280	-71.17708	662 m	76.32880	-71.13821	658 m	3 min
177	01/09/2018	67.47842	-63.68186	694 m	67.47237	-63.64231	568 m	3 min

Station	Diversity	Isotopes	Microplastics
312	X	X	X
QMG1	X	X	X
QMG2	X		
QMG4	X	X	X
QMG3	X		

Station	Diversity	Isotopes	Microplastics
QMGM	X	X	X
101	X	X	X
115	X	X	X
177	X	X	X

Table 33-3 Water collected from the CTD-Rosette during Leg 3 (Amundsen 2018).

Station ID	Date	Latitude	Longitude	Bottom depth	SCM depth
312	19/08/2018	69.17643	-100.69253	56 m	30 m
QMG1	21/08/2018	68.47330	-99.88422	28 m	10 m*
QMG4	22/08/2018	68.47858	-103.43177	55 m	32 m
QMGM	22/08/2018	68.29917	-101.74062	100 m	46 m
101	28/08/2018	76.38338	-77.39462	338 m	37 m
115 - Cast 1	29/08/2018	76.33262	-71.19660	—	32 m

115 - Cast 2	29/08/2018	76.33252	-71.18178	641 m	—
177	01/09/2018	67.48002	-63.67072	670 m	20 m

* No SCM so water collected at 10 m depth.

29.3 Preliminary Results

At this point, we do not know exactly if spatial and temporal variability of benthic diversity is governed by sediment type, food availability or other environmental variables. Samples collected require further analysis. For detailed results, identification of organisms and sediment analyses will be carried on in home labs.

29.4 Acknowledgement

We would like to thank the CCGS *Amundsen* crew for their help with deploying the gears. Our special grateful are going to captain Claude Lafrance and bosun Léon-Noël Dufour for their professionalism and help with realizing our projects. We wish them a great retirement! We finally thank the chief scientist Alexandre Forest.

ArcticNet, Amundsen Science & CCGS *Amundsen* crew are very professional, experienced and competent. Thanks to this great team!

30 Macrofauna Diversity across Hudson Bay Complex – Legs 1 and 2a

Project leader: Philippe Archambault[1] (philippe_archambault@bio.ulaval.ca)
Cruise participants – Legs 1 and 2a: Marie Pierrejean[1] and Catherine Van Doorn[1]
[1]*Laboratoire d'écologie benthique, Université Laval, Québec, QC, Canada*

30.1 Introduction

Most epibenthic (i.e. benthic organisms living at the surface of sediments) and endobenthic (i.e. living inside the sediments) are either sessile or have low mobility. They are therefore directly affected by changes in their environment. For instance, global change affects physical parameters such as sea ice extent and thickness, but also impacts ecosystem functioning and the structure of food webs including those of benthic communities (Darnis et al. 2012, Kedra et al. 2015).

Benthic invertebrates of the Hudson Bay Complex are exposed to two major stresses in space and time: climate change and freshwater discharge from several rivers (Grant Ingram and Prinsenberg1998). These stressors will also likely cause an increase in shipping transport (Arctic-Council 2009) through the expansion of fisheries in the Hudson Bay Complex or shipping activities (e.g. Churchill and Deception Bay ports) and the establishment of aquatic invasive species because of ballast water (Goldsmit et al. 2017). The RCP8.5 emission scenario predicts a salinity anomaly greater than or equal to -0.5 PSU along coastlines (NOAA-ESRL). In addition to climate-induced changes, freshwater discharge along the coastlines will show notable increase in the southeastern portion of the Nelson basin (Clair et al. 1998, McCullough et al. 2012). This could have great consequences on ecological communities, as salinity gradients control species richness (Witman et al. 2008) and can influence the distribution of species.

Many studies have shown a temporal shift in Arctic benthic communities (Cusson et al. 2007; Renaud et al. 2007; Taylor et al. 2017), but data for the Hudson Bay Complex are scarce and few recent data are available. However, knowledge on benthic biodiversity in the Hudson Bay Complex has increased during the past decade thanks to scientific programs like MERICA (2003), ArcticNet (2010), CHONe (Snelgrove et al. 2012), BaySys (2016), and BriGhT (Bridging Global Change, Inuit Health and the Transforming Arctic Ocean) (2017). The main objective is to describe benthic communities in the Hudson Bay Complex and to determine the relationship between the distribution of organisms and environmental parameters. In the second time, to link the presence of a given community with environmental parameters, a community distribution model will be developed.

30.2 Methodology

At 22 stations, the Agassiz trawl (Figure 45.1) was deployed to collect macrofauna. Catches were passed through a 2 mm mesh sieve. When possible, specimens were identified to the lowest taxonomic level, then count and weight. The unidentified specimens were preserved in a

4% seawater-formalin solution. Fishes collected and some benthic organisms were kept for Fortier's laboratory and contaminants. Corals and sponges were preserved.

Figure 30-1 Sampling with the agassiz trawl

At 21 stations, the box core was deployed to quantitatively sample diversity, abundance and biomass of infauna and to sample sediment. Unfortunately, the bottom of XX sites was sandy or rocky and the sampling was not possible. Sediments of a surface area of 0.125 m^2 and 10-15 cm in depth were collected and sieved through a 0.5 mm mesh and preserved in a 4% formaldehyde solution for further identification in the laboratory. Sub-cores of sediments were collected for sediment pigment content, organic matter and sediment grain size; for sediment pigments, the top 1 cm was collected, although for sediment grain size, the top 5 cm was collected. Sediment pigment samples were frozen at -80°C, and organic matter and sediment grain size samples were frozen at -20°C.

The small benthic trawl was deployed at 4 stations and one time from the barge during Leg 1. It was deployed at a depth of 15m at station 17 but did not seem to reach the bottom according to the species found. At station 22, the trawl stayed stuck and got ripped: we weren't able to sample. It was fixed for the next station. It was deployed in the Nelson River but we weren't able to sample due to the weather. In total, 3 samples were taken at station 17, 19 and 34.

During Leg 2a, the small trawl was deployed near Inukjuak at a station we have called 736b. It was also deployed near Salluit at station 689b. Specifics on the stations are detailed in Table 45.1 below.

Table 35-1 Specifics on the small trawl stations of Leg 2a

Station #	Start		Finish		Speed (kn)	Trawling Time (min)	Salinity
	Lat.	Long.	Lat.	Long.			
736b	58°26'.448 N	78°06' .563 W	58°26'.410 N	78°06' .644 W	2 - 1.4	3	
689b-1	62°17'.172 N	75°30'.90 W	62°17'.154 N	75°30'.93 W	0.6-1.1	1	
689b-2	62°17'.141 N	75°30'.92 W	62°17'.143 N	75°30'.95 W	0.8-1.2	1.5	
689b-3	62°17'.110 N	75°30'.60 W	62°17'.081 N	75°30'.53 W	1.6-1.5	2	

30.3 Acknowledgement

We gratefully thank the chief scientist and the Captain of the Amundsen. We also thank the day and night deck crew for their help with the gear deployment.

31 High Resolution Survey of Oceanic Dimethylsulfide in Contrasted Marine Environments of the Canadian Arctic – Leg 2

Project leader: Martine Lizotte[1] (martine.lizotte@go.ulaval.ca)
Cruise participants: Martine Lizotte[1] and Joanie St-Onge[1]
[1]*Biology Department, Université Laval, Québec, QC, Canada*

31.1 Introduction

Ongoing changes in the Arctic Ocean, including reductions in snow cover as well as sea ice extent and thickness could significantly modify light availability in surface waters below the ice and at its margin and impact the dynamics of microorganisms and their production of organic matter including the biogenic climate-active gas dimethylsulfide (DMS). The main objectives of Leg 2 included:

1. deploying a high-frequency autonomous underway sampling instrument (MIMS – Membrane Inlet Mass Spectrometer) in order to obtain greater spatial and temporal resolution of surface concentrations of DMS across contrasted environments (open waters, ice, marginal ice zones, etc);

2. conducting parallel and discrete sampling of dimethylsulfoniopropionate (DMSP, precursor of DMS);

3. offering mentorship during the International PhD School (Leg 2a). Constant monitoring of ship coordinates, sea surface temperature, salinity and chlorophyll will allow our team to establish potential correlation between environmental factors and methylated sulfur compounds.

31.1 Methodology

The MIMS was successfully deployed between July 5th 2018 and July 23rd 2018. During this time we prioritized the ship's transits between stations to increase the chances of capturing fronts and physical features related to the presence of ice and we conducted maintenance/cleaning procedures on the instrument during stationary stations. Our team also participated in the mentorship of student's from the Sentinel North International PhD School.

31.1 Preliminary Results

Almost 3 weeks of DMS data at 10 minutes frequency are available for AN2018 Legs 2a and 2b. More than 750 data points were collected during Legs 2a/2b. We also collected and analyzed discrete DMS and DMSP samples from the rosette deployments at stations 2 to 6 during the IPS part of Leg 2. The large data matrix will need validation and post-sampling processing before it can be used. However, preliminary results show that the presence of ice cover conveys a specific DMS signature to the underlying surface waters, a feature that had been observed during the AN2016 and AN2017 cruises. Higher concentrations of DMS were measured in heavy and

moderate ice conditions as well as in coastal areas. Further analysis of the dataset will determine if modifications in salinity and temperature may help explain these features.

31.2 Acknowledgment

The success of AN2018 Leg 2 cruise is largely attributable to the rigorous planning and preparations done by ArcticNet/Amundsen Science personnel, namely Alexandre Forest and Anissa Merzouk as well as their entire team. The generous leadership of Captain Alain Gariépy and the remarkable work conducted by the entire coast guard personnel on board the ship. The tireless work by both chief scientists (Jean-Éric Tremblay and Marcel Babin) and both coordinators (Marie-France Gévry and Marie-Hélène Forget) is also at the core of the success of this cruise. Thank you to ArcticNet/Amundsen Science technicians Thomas Linkowski and Lou Tisné as well as to Claudie Marec for rosette operations. Our sincerest acknowledgements to Chief and first engineers Louis-Philippe Dion and David Quirion for punctual help along the way, as well as chef Michel Viel and all the kitchen staff and stewards for keeping us incredibly well fed and very comfortable during the cruise.

32 Seabed Mapping, MVP and Sub-bottom Profiling – Legs 1, 2 and 3

Project leaders: Alexandre Forest[1] (alexandre.forest@as.ulaval.ca)
Cruise participant - Leg 1: Matt Downton[2]
Cruise participants - Leg 2a: Gabriel Joyal[1] and Luca Arduini Plaisant[1]
Cruise participant - Leg 2b: Luca Arduini Plaisant[1]
Cruise participant - Leg 2c: Luca Arduini Plaisant[1]
Cruise participants - Leg 3: Gabriel Joyal[1] and Dominique St-Hilaire[1]
[1] *Amundsen Science, Université Laval, Québec, QC, Canada*
[2] *School of Ocean Technology, Fisheries and Marine Institute of Newfoundland and Labrador, St. John's, NL, Canada*

32.1 Introduction

32.1.1 *Leg 1*

The BaySys 2018 Amundsen Leg 1 cruise took place from May 25th to July 5th 2018. The Marine Geosciences Lab. (MGL – Université Laval) was onboard and responsible for multibeam and sub-bottom data acquisition. The MGL has been mainly involved in mapping the seabed morphology and in acquiring sub-bottom stratigraphy during transits, choosing appropriate coring sites, assisting mooring deployment and recovery as well as deploying the Moving Vessel Profiler (MVP). This cruise report presents the instruments, methods and preliminary results for Leg 1.

32.1.2 *Leg 2*

The 2018 Amundsen expedition for the Leg 2 was divided in 3 independent parts:

Leg 2A: This Leg took place from July 5th to July 13th, departing from Churchill to Iqualuit. During this leg, we were two operators for the multibeam system and the sub-bottom, Gabriel and I. As it was my first time on this ship and with the whole system, it was really a good thing being alongside someone as experienced as Gabriel is.

Leg 2B: During this Leg, the Amundsen hosted the "Sentinel North" Post- Doctorate School (IPS), from July 13th to July 24th. Gabriel left for this Leg, letting me alone as the multibeam operator onboard. We departed from Iqualuit, going up North along the eastern cost of the Baffin Island, to Quiqiktarjuak and coming back at Iqualuit.

Leg 2C: Taking place from the 24th of July to August 16th, departing from Iqaluit, going down South to the Labrador sea, steaming East to the South-West of Greenland and then coming back North toward Scott Inlet and Resolute Bay, the final destination.

32.1.3 *Leg 3*

Leg 3 of the 2018 Amundsen expedition covered extensive territory from Queen Maud Gulf to the North of Baffin Bay and all the way south to Quebec City (Figure 30.1). Most of the mapping

was conducted on an opportunistic basis during transit, while in standby or in support of coring and mooring operations. Only one dedicated mapping operation was carried out during Leg 3.

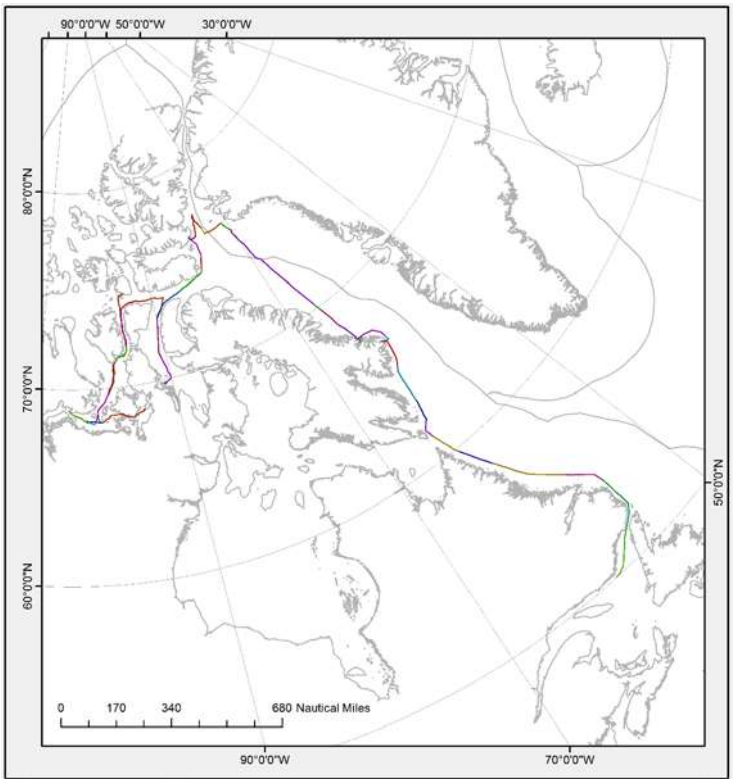

Figure 32-1 Map of the transit of the CCGS *Amundsen* during Leg 3 of the 2018 mission

32.2 Methodology

32.2.1 *Kongsberg EM302 Multibeam Sonar*

The Amundsen is equipped with an EM302 multibeam sonar operated with the Seafloor Information System (SIS). Attitude is given by an Applanix POS-MV receiving RTCM corrections from a CNAV 3050 GPS receiver. Position accuracies were approximatively < 0.8m in planimetry and < 1m in altimetry. Beam forming at the transducer head was done by using an AML probe. CTD-Rosette casts, when available, were used for sound speed corrections. During long periods without CTD casts, the WOA09 model was used.

32.2.2 *Knudsen 3260 CHIRP Sub-bottom Profiler*

Since May 2016, a new Knudsen 3260 deck unit has been installed onboard the Amundsen. It was acquired to replace the old 320-BR system that shown signs of high degradation at the end of the 2015 field season. The new system now operates using a USB connector instead of a SCSII communication port. We also installed a new operating computer (HP EliteDesk). Sub-bottom profiles were acquired all along transits at a frequency of 3.5 kHz to image sub-bottom stratigraphy of the seafloor.

32.2.3 *Moving Vessel Profiler (MVP) 300*

During Leg 1, four MVP transects were performed using a Moving Vessel Profiler (MVP 300) towed behind the ship at 8-10 kts. The MVP measures temperature, salinity, transmissivity, dissolved O2, fluorescence and sound velocity. Mainly, our team used MVP data to correct for sound velocity during transit mapping, but these transects were also used to visualize water column properties for physical and biological purposes.

32.3 Preliminary Results

All the data acquired during the cruise was post-processed in real-time using the CARIS HIPS&SIPS 10.4 software. Raw data was converted into the HIPS & SIPS format using Caris Onboard version 1.4. Surfaces were then created to allow for data cleaning in Subset Editor or in Swath Editor. This post-processing phase is essential to rapidly detect any anomaly in the data collection. Tide derived from Webtide was then applied to the data, along with sound velocity correction using CTD profiles when available. The final addition of the 2018 data will be done upon the return of the ship in Quebec City.

32.3.1 *Leg 1*

Opportunistic Mapping

The mapping of the Arctic seabed is an important objective of the BaySys program. Transits routes were surveyed systematically in order to increase the multibeam dataset. These data will be shared with the Canadian Hydrographic Service (CHS) to update marine charts and might be useful for future work with Amundsen Science. Overall, the multibeam worked well and generated new data in previously poorly charted areas.

Since 2016, our team has been developing a bathymetry database to easily access all the bathymetry data acquired since the beginning of the ArcticNet program. This ArcMap based database is a raster catalog of more than 3500 data grids (15’x30’ spatial extent) that can be rapidly added to navigation charts in order to improve the multibeam coverage of the Arctic (Figure 30.3). In 2017, the sub-bottom profiles acquired since 2003 were added to this database, making it easier to choose alternative coring sites during the cruise depending on ice conditions.

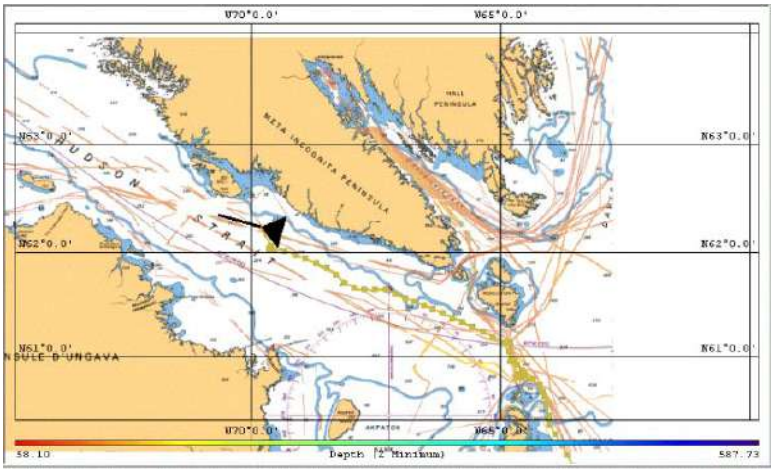

Figure 32-2 Example of opportunistic mapping in Hudson Strait.

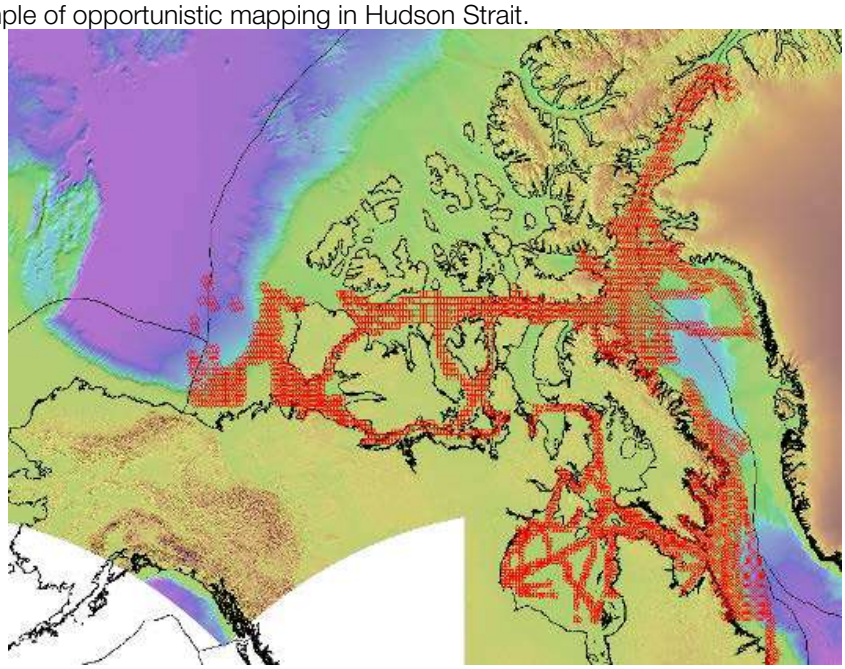

Figure 32-3 Image of the Amundsen Bathy-CHIRP Database for bathymetric and sub-bottom data collection.

MVP Transect

During Leg 1, six MVP transects were performed. Due to ice and sheave issues, only four MVP transects provided useful data (1801003 – 1801006). The casts (Table 30.1) were performed as part of the BaySys program. Figure 30.4 to Figure 30.7 shows the preliminary data.

Table 38-1 Description of the relevant MVP transects performed during Leg 1

MVP transect	Location	Speed (kts)	Nb. of casts
1801003	62.86859°N 88.92363°W – 63.29666°N 90.38346°W	8-10	124
1801004	61.84291°N 92.13785°W – 61.37693°N 90.9538°W	8-10	113
1801005	61.38983°N 90.95297°W – 61.00155°N 90.07916°W	8-10	93
1801006	62.20248°N 88.39438°W – 62.5818°N 90.91398°W	8-10	247

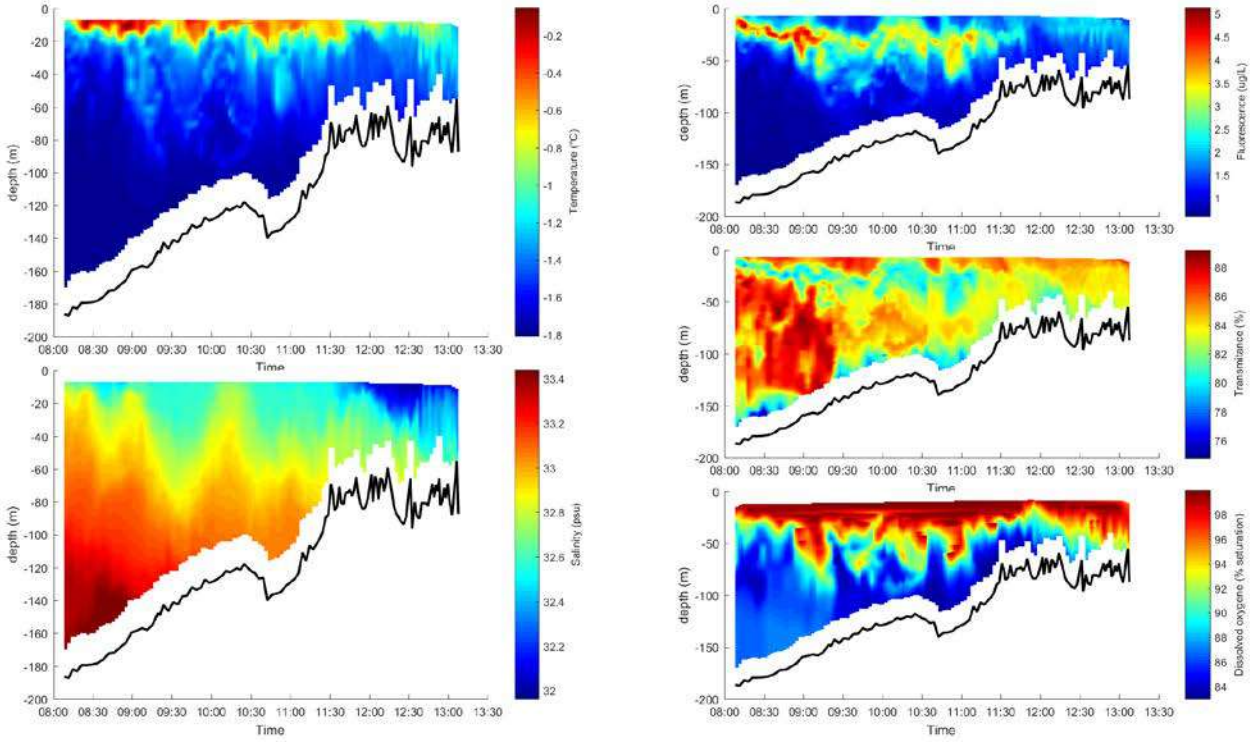

Figure 32-4 Preliminary results of the MVP transect 1801003 performed during Leg 1 displaying Temperature, Salinity, Fluorescence, Transmittance, and Dissolved Oxygen.

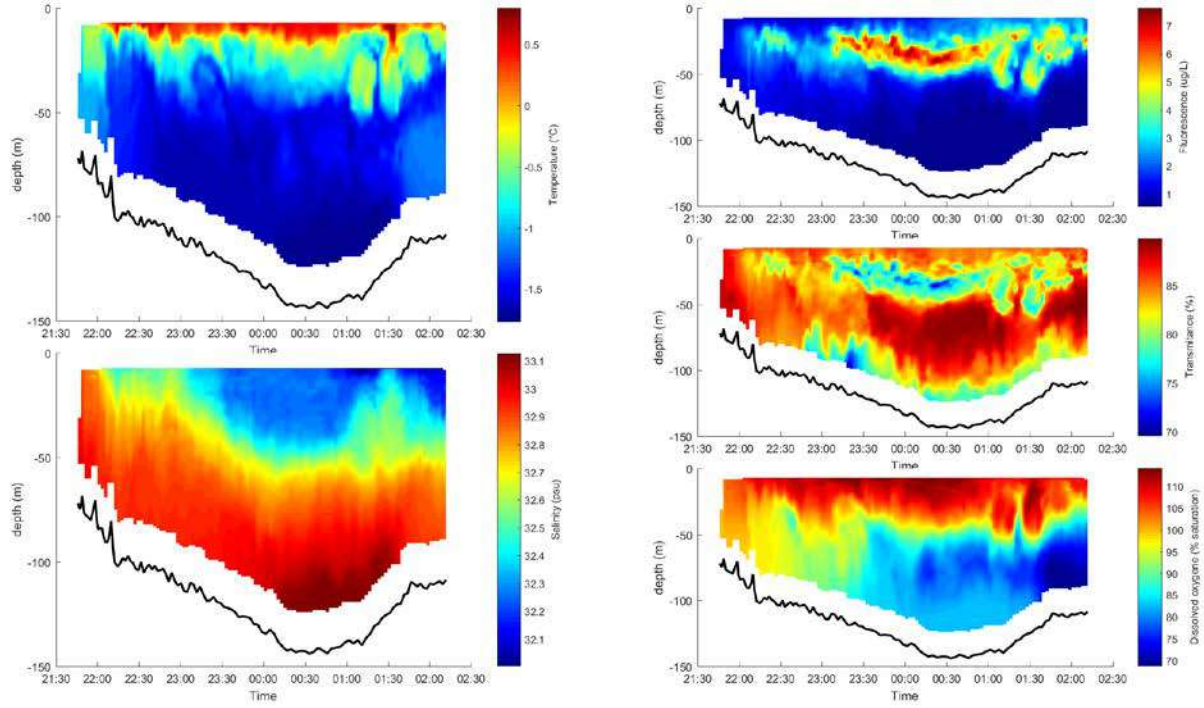

Figure 32-5 Preliminary results of the MVP transect 1801004 performed during Leg 1 displaying Temperature, Salinity, Fluorescence, Transmittance, and Dissolved Oxygen

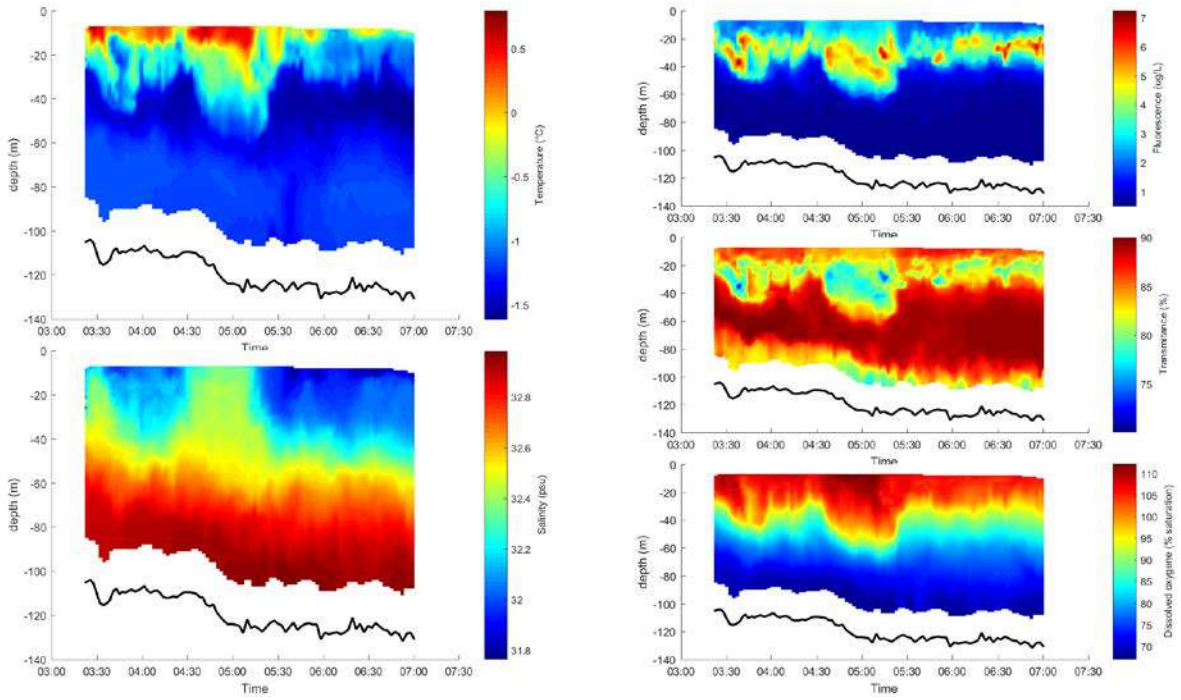

Figure 32-6 Preliminary results of the MVP transect 1801005 performed during Leg 1 displaying Temperature, Salinity, Fluorescence, Transmittance, and Dissolved Oxygen.

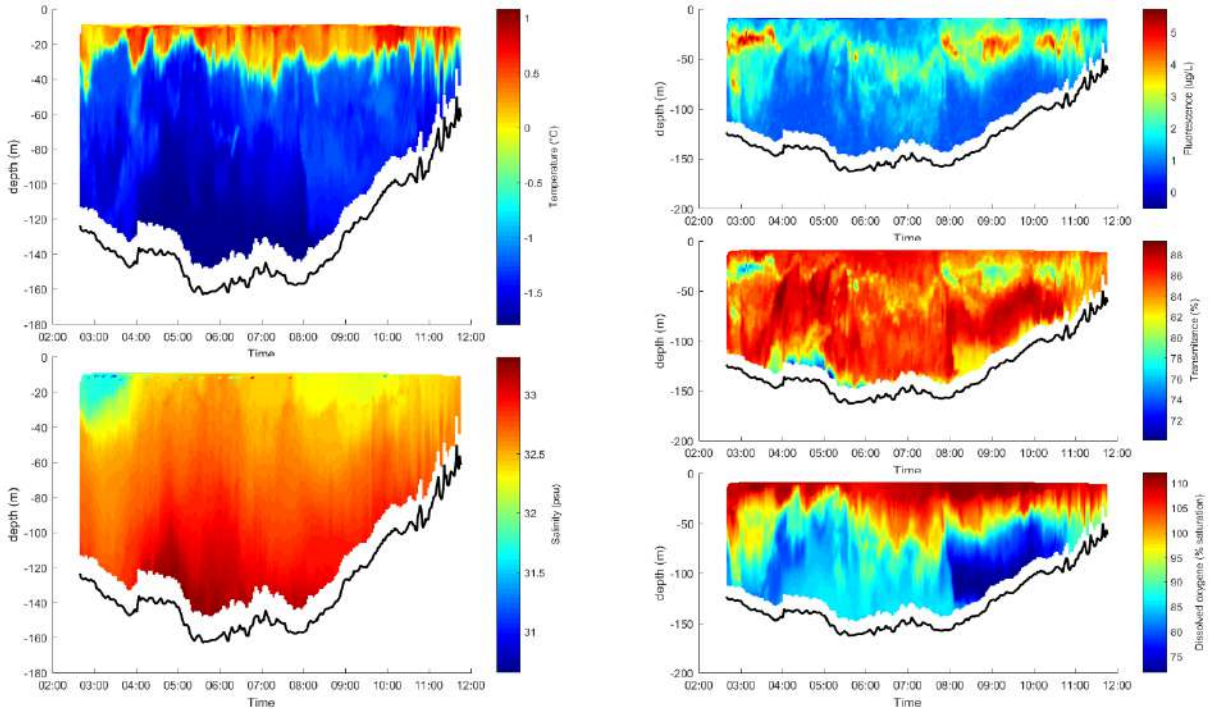

Figure 32-7 Preliminary results of the MVP transect 1801006 performed during Leg 1 displaying Temperature, Salinity, Fluorescence, Transmittance, and Dissolved Oxygen

Mooring Deployment and Recovery

The role of the mapping team during mooring deployment and recovery was to:

1) Ensure the mooring was still in its position (identify the buoys and the exact position);
2) Validate the depths of the deployment sites;
3) Map the surface morphology of the sites;
4) Determine the verticality of the moorings after deployment.

The survey lines from the mooring were processed in CARIS HIPS&SIPS after the survey to find the exact position of the mooring. The procedure started with the visualization of the water column data to find the buoys (Figure 30.8). The buoys scattering was added to bathymetry to find the final position of the deployment.

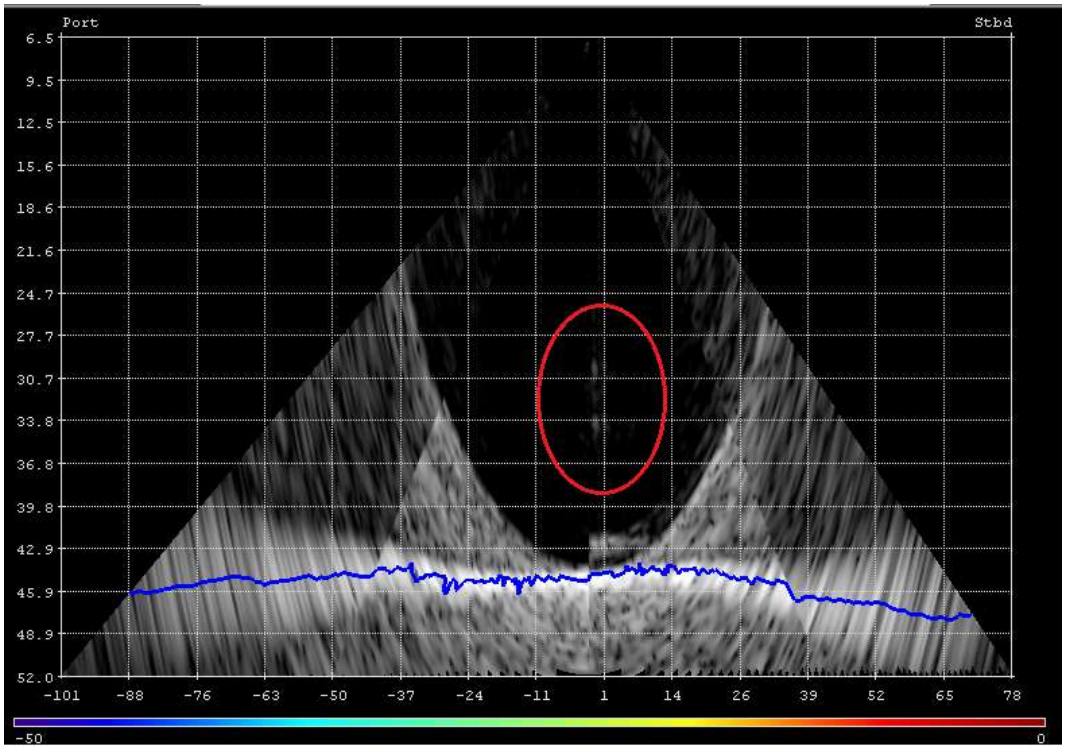

Figure 32-8 SIS water Column display of Mooring on July 25th before recovery. The red circle shows the buoys

Sediment cores

During Leg 1, many box cores were sampled. Coring sites were chosen in real time while doing a seismic survey, or by analysing sub-bottom profiles of previous years. Details of the cores, their location and length of recovery, as well as the targeted type of sediment/feature are presented in the coring team report.

Figures were produce by the mapping team for every coring sites to indicate the target on the acoustic sub-bottom profile (Figure 30.9).

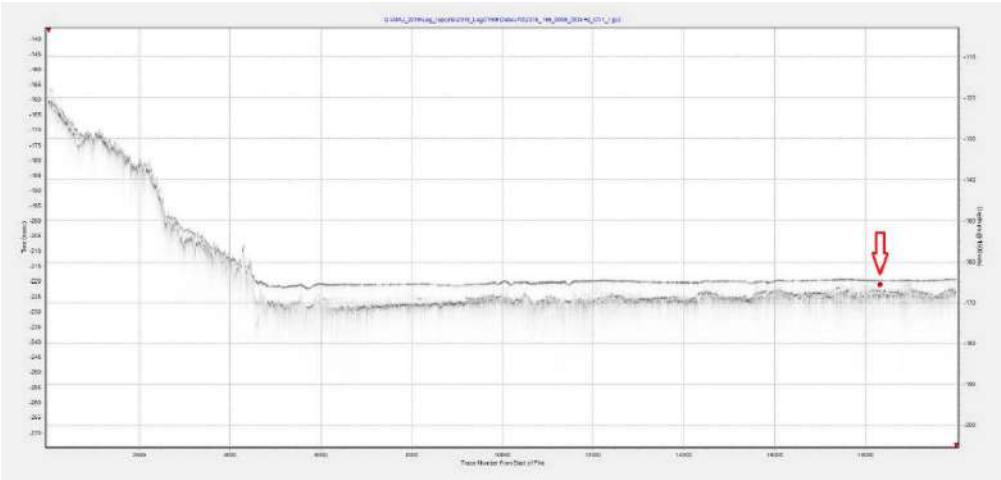

Figure 32-9 Location of the core site of near Rankin Inlet on the acoustic subbottom profile

32.3.2 *Leg 2a*

The initial transit for this leg was to cross the Hudson from West (Churchill) to East (Inukjuak). Unfortunatly, according to the ice conditions in this region for this period, we had to figure out a way to escape the huge ice pack in the middle of Hudson Bay. The scientific mission chief decided with the captain to cruise down South of the Bay to avoid the most important part of the ice.

However, we have been trapped in 9+/10 ice conditions at the East Belcher Islands, letting Jean-Eric no others choices than cancelling some stations. During this Leg, the mapping was not a principal objective and none of the equipment needed a “pre-deployment” mapping (essentially nets and CTD rosette).

32.3.3 *Leg 2b*

During this almost complete scientific crew change, we moved from two multibeam and sub-bottom operators to one, 24/7. Meaning that I was trying my best to keep the system running, without any errors (celerity, range, others) during the day and setting the appropriate parameters before going to bed.

How the school onboard was working was very different from a usual scientific campaign, running 24/7. In fact, the 19 students and 21 “mentors” were separated in different activities/courses depending on the day. All the activities were taking place in several stations, from Eastern Baffin to inside the Quiqiktarjuak fjords.

I was trying to use the ship as efficiently as I could during the night to do some mapping, if we had no transit to do. The scientific mission chief, Marcel Babin, allowed me to add to the schedule the mapping of one of the “priority zones” East of Broughton Island as well as Coronation Fjord.

Arriving East of Broughton Island, we undertook multiple lines in the same area to try localize a lost mooring from Julek Chawarsky. In fact, the mooring sank because some polar bears have

destroyed the floating buoy. We supposed that the equipment was on the seafloor, with a little reflective buoy (initially to maintain verticality) attached to a 15m rope that we tried to localize analyzing the water column data from the mooring. With the last known GPS position, we tried multiple lines, with different bearings, to isolate some echoes that I spot. Once those echo were isolated, I added them to an additional bathymetry layer in order to build a 3D view of these, with the bottom surface.

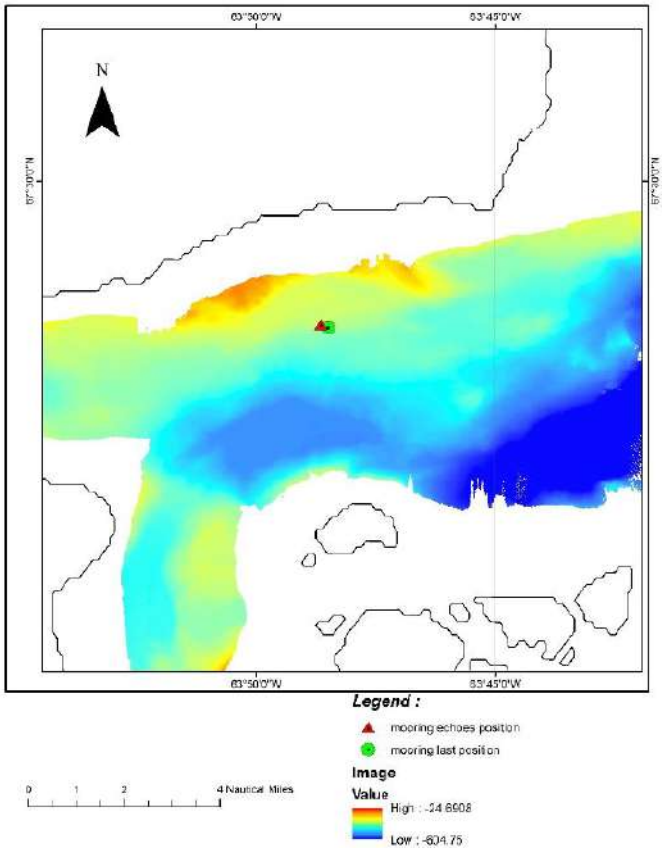

Figure 32-10 Map of the last known position of the mooring & isolated echoes

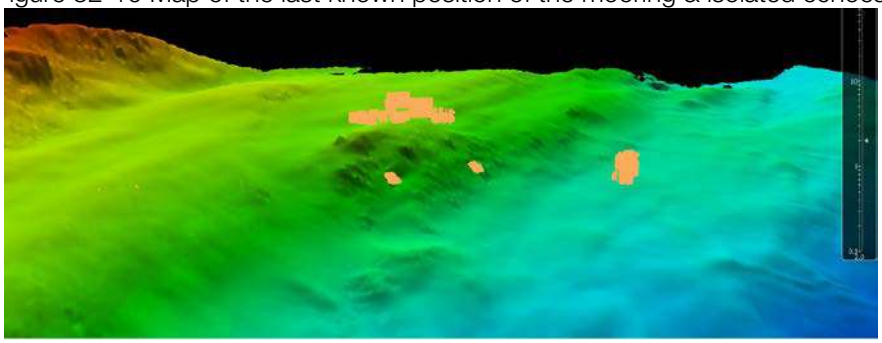

Figure 32-11 3D model of the bottom and the isolated echoes

As we can see in Figure 34.11, there is two main locations for the spotted echoes and one of these two is located on a slope. However, even if the good buoy position was spotted (no clean

reflectors, not a strong backscattering echo), the mooring recovery should have been undertaken with a rope and a hook, as the mooring is not equipped with an acoustic release.

The captain and Julek decided not to undertake this operation has the echoes were not strong enough to be sure of the position.

After the Quiqiktarjuak community visit, I mapped the Coronation Fjord, to the very end of it, 150m away from the glacier as shown in the map below:

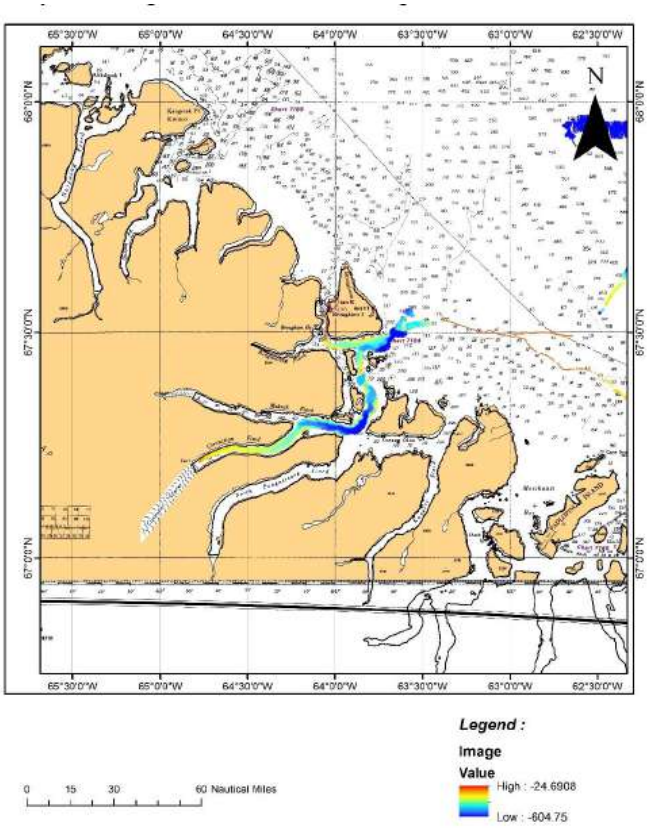

Figure 32-12 Map of the Coronation fjord and East Broughton 2018 mapping

32.3.4 *Leg 2c*

This Leg was from far away the most “challenging” for me, as a multibeam operator, because I had to answer the different Scientifics needs as the officer’s one. In fact, before every box-core / gravity-core deployment, ROV dives, some mapping (MBES or/and SBP) has to be done.

I had a lot of freedom regarding the process I wanted to use to acquire the best data possible in the given time. According to the GEBCO/IBCAO charts, I could make myself an idea about the global shape of the bathymetry and plan a proper line planning.

For example, before a box-core, we ran a line over the supposed location to confirm or cancel the sampling, according to the nature of the bottom. After the deployment, I had to produce

some map of the box-core location on the bottom, compare to the initial station as shown on the following map:

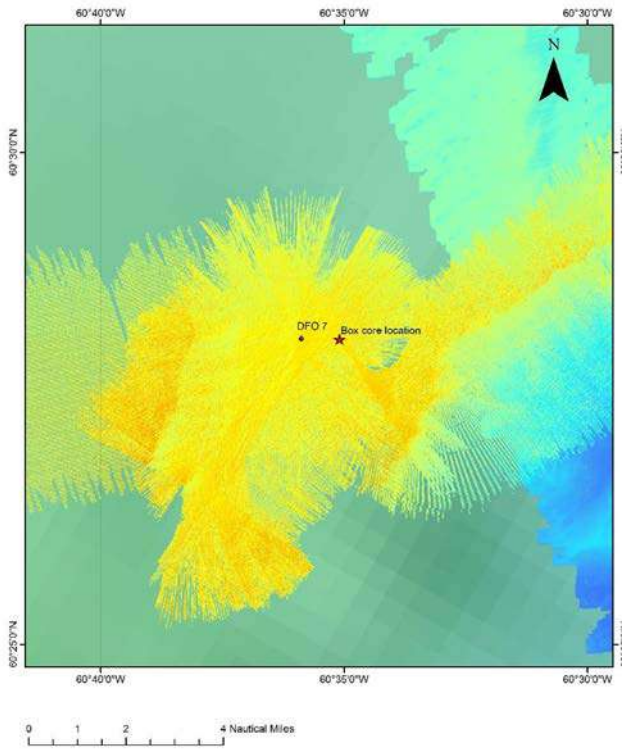

Figure 32-13 map of a box-core bottom location

The Leg 2C scientific program had some specific areas to map, to put into relief some geomorphological feature or to help supporting some previous studies. The two main locations that needed to be mapped were “Saglek Bank” and “Lophelia site” (SWGreenland). In addition to transit mapping and several pre-deployment equipment mapping, the dataset acquired after this Leg is pretty impressive and covers a very large area.

The first area mapped in Saglek Bank was arbitrary selected, as a support for several ROV dives. However, during one of these “pre-ROV” mapping, some interesting geomorphological features such as ridges and sand dunes were spotted, inducing additional mapping time for these area, resulting in a great coverage of the continental slope:

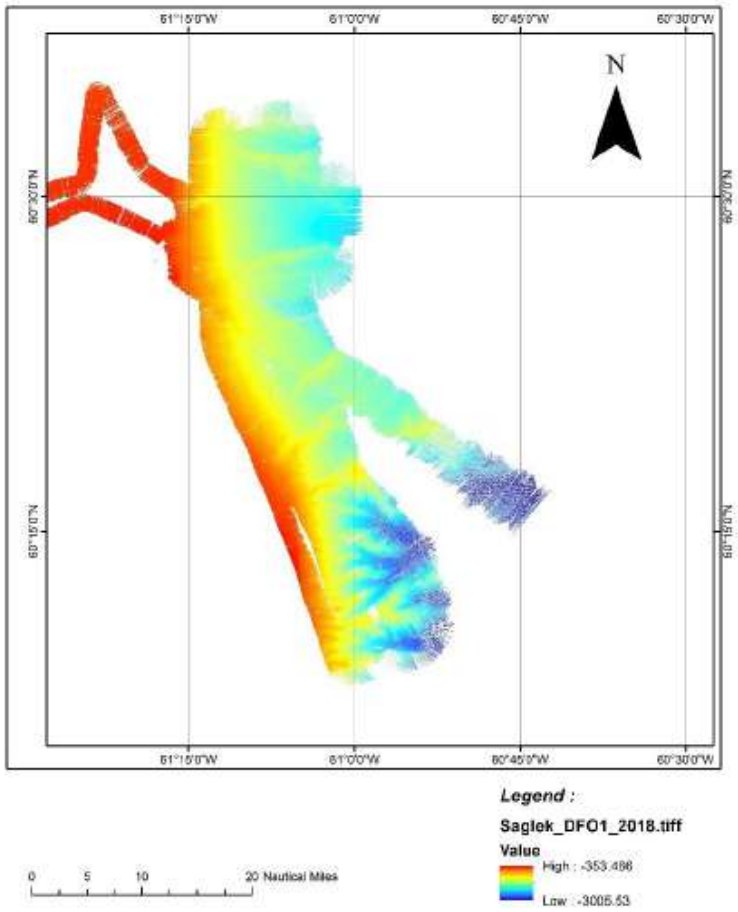

Figure 32-14 Map of the Saglek bank continental slope and ridges (MBES)

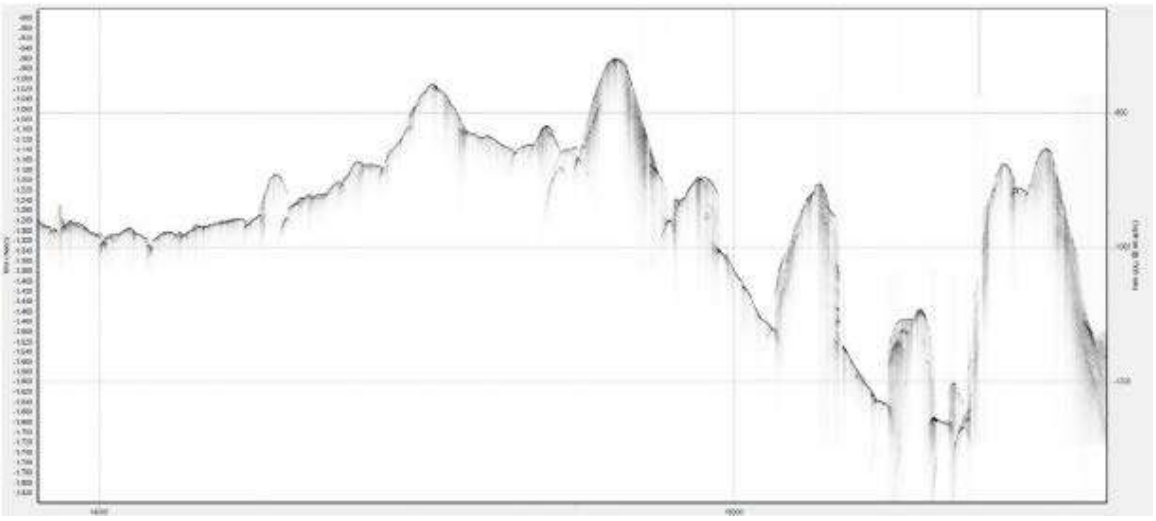

Figure 32-15 Sub-bottom profile of the Saglek bank ridges

The second area of interest where some mapping was programmed was the Lophelia site in the South-West of Greenland. The mapping was necessary to confirm the depths of a previous survey undertaken in this area before the ROV dive on the coral reef. The purple star represent

the canyon and the reef where the ROV dive took place and the green one shows the western canyon mapped during the night:

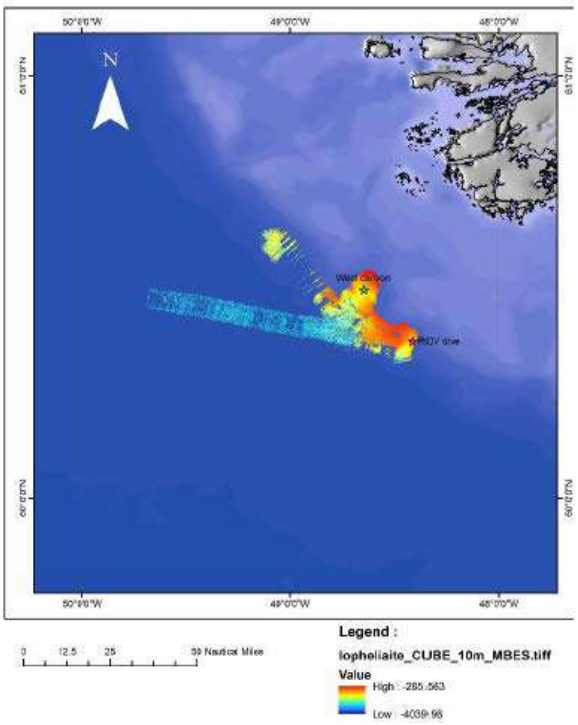

Figure 32-16 Area mapped in the surroundings of the Lophelia site

The data gathered during the mapping on the coral reef was really good and permitted to construct a 3D model of the bottom floor in this area, which was not covered from the previous Germans survey (only dataset available in this area).

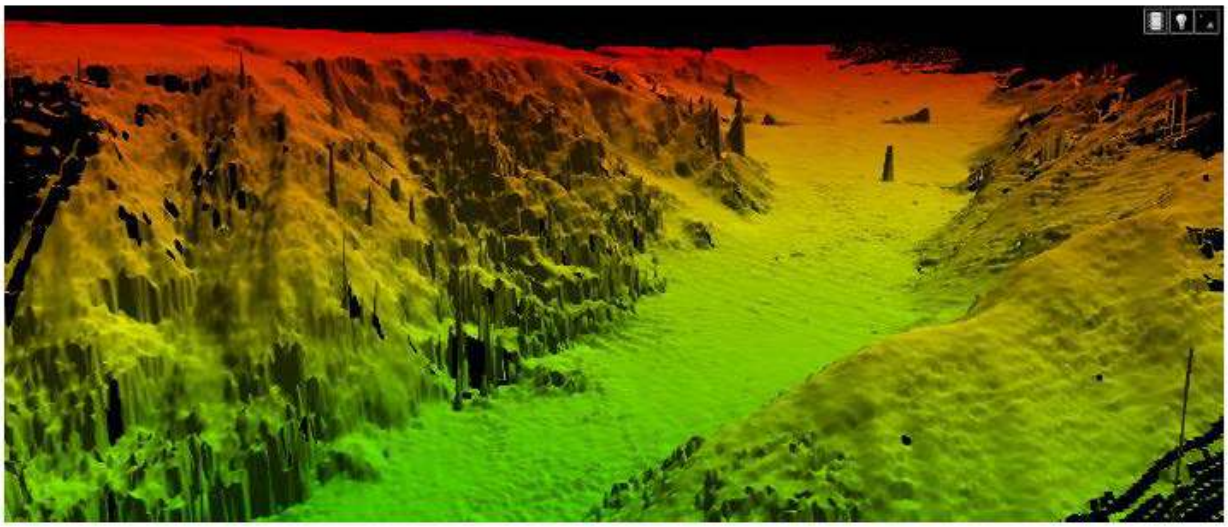

Figure 32-17 view of the coral reef in Lophelia

According to the GEBCO bathymetry, we spotted an interesting channel on the West of Lophelia site that wasn't mapped at all. This mapping time permits to increase the bathymetric data

coverage of this area and to spot some interesting geomorphological features such as landslides (green circles):

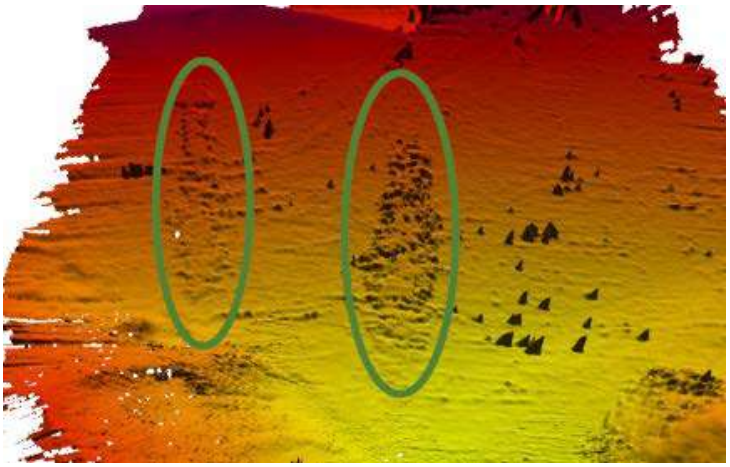

Figure 32-18 Landslides spotted in the western canyon

All the data acquired in the Greenland waters has been transmitted to the Danish Hydrographic Service.

The end of the leg was just transit mapping toward disko fan, Scott Inlet then Pond Inlet and finally Resolute Bay.

However, during the steaming time, some interesting geomorphological features, certainly due to icebergs, has been spotted before arriving at the Disko fan station :

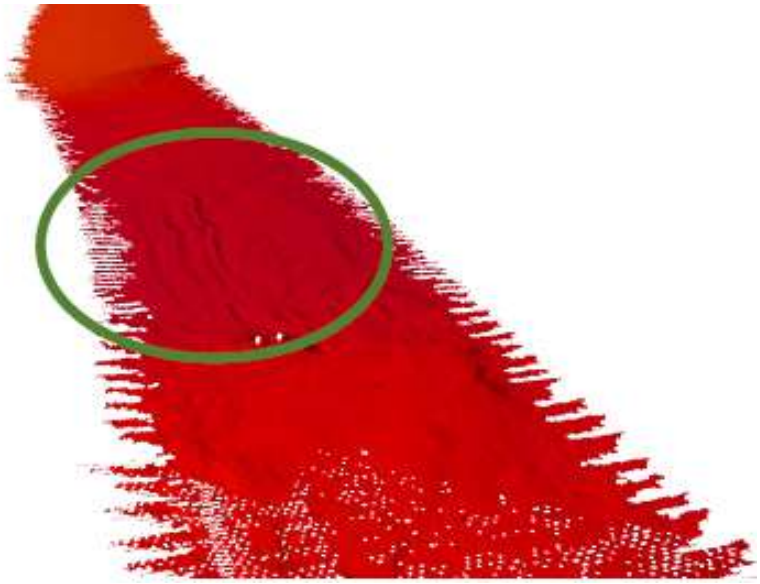

Figure 32-19 3D view of an iceberg scour by 800m depth

32.3.5 *Leg 3*

Opportunistic Data Acquisition

MBES data was continuously acquired during transit despite heavy sea ice conditions, especially in Peel Sound, Franklin Strait and near Talbot Inlet off the coast of Ellesmere Island. Rough seas were also encountered, mostly in the area south of Qikiqtarjuaq and in the Labrador Sea. Both extensive sea ice and rough seas affected the quality of the MBES and seismic data acquired during Leg 3.

Rough seas forced us to take shelter in Sunneshine Fjord, Ellesmere Island, approximately 150 km to the SE of Qikiqtarjuaq, for a period of 32 hours. Opportunistic mapping of the fjord was conducted then, along with a CTD cast and a gravity core (Figure 30.20, Figure 30.21, Figure 30.22). The results from the sediment and contaminants analysis from this gravity core will be of interest because of its proximity to a DEW line site on the North shore of the Fjord, which appear to be currently undergoing decontamination.

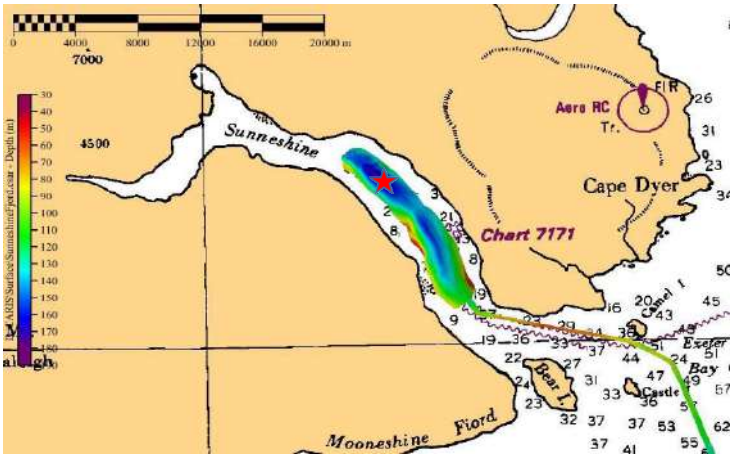

Figure 32-20 Extent of the opportunistic mapping in Sunneshine Fjord. The deepest basin is 175 m deep. The location of the gravity core is shown by a red star.

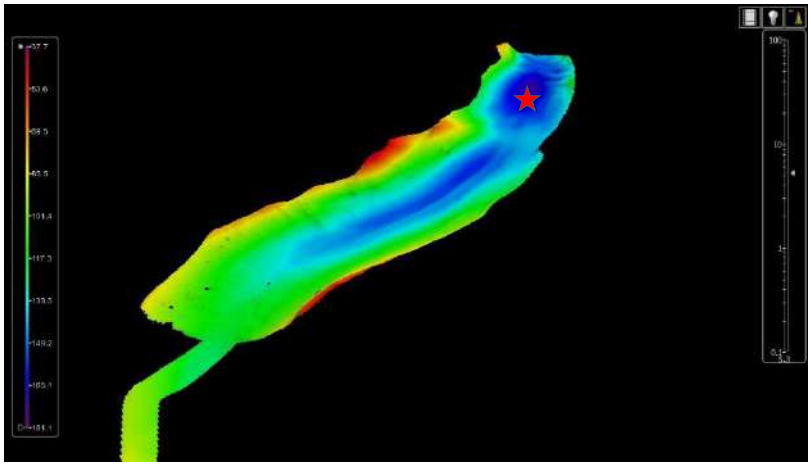

Figure 32-21 3D representation of the seabed of Sunneshine Fjord, Ellesmere Island. The red star shows the approximate location of the gravity core.

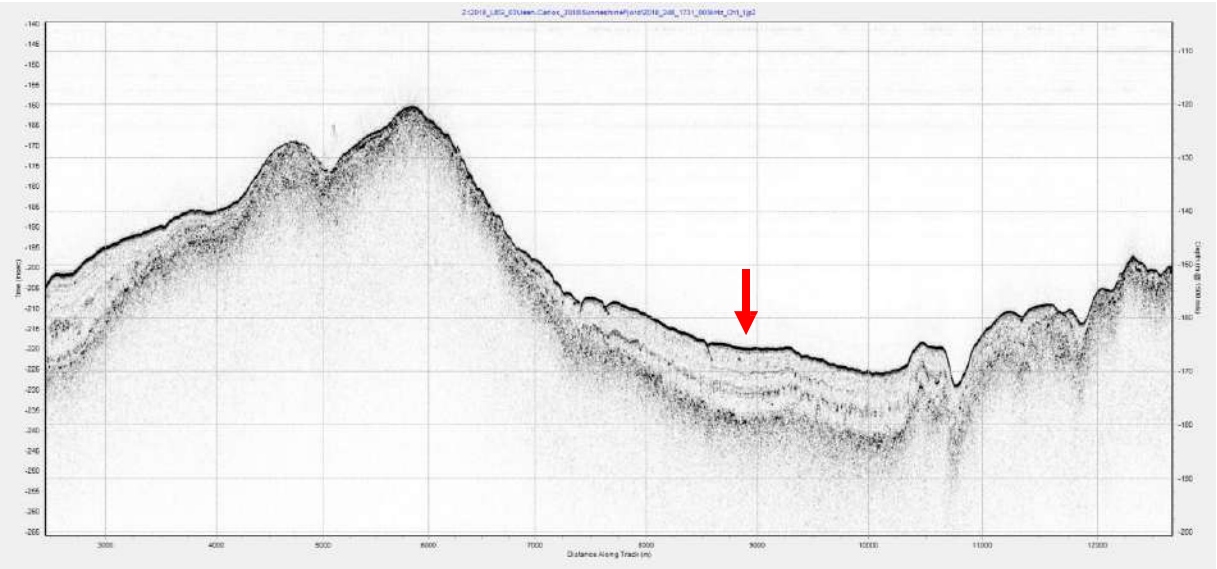

Figure 32-22 Seismic profile of the western basin of Sunneshine Fjord showing the location of the gravity core. Over 15 meters of sediment is present in this basin, and surface sediment testify of anoxic conditions.

Dedicated Mapping Operations

Three dedicated mapping operations were planned during Leg 3. However, due to delays induced by Search and Rescue operations and delays related to cargo, only one dedicated mapping took place near Qikiqtarjuaq, were former grounding spots for the decaying Peterman Ice Island were mapped during the night of the VIPs visit, August 31st-September 1st.

32.4 Incidents

32.4.1 *Failures of the MBES System*

On the night of August 26th 2018, the MBES system failed to acquire data. MBES operators only noticed this in the following morning. The following message was given by the SIS System: AltVel on PU com2 unavailable. It is hypothesized that the problem lied with an error in communication with the POSMV. The SIS system was rebooted and started recording data following the reboot.

The following 12 hours were characterized by transiting through heavy sea ice and a frontal collision with an iceberg. The MBES system didn't perform well, even after sailing conditions came back to ideal for mapping purposes.

On August 28th, at approximately UTC 18:30, two of the sectors (starboard side) of the MBES stopped transmitting. The Processing Unit (PU) was rebooted twice, then a BIST (self-analysis tool for the EM302) test was conducted. Results from the test indicate numerous failed tests on the transceiver (TX), including failed TX power and firmware tests, multiple failed TX channels tests, mostly on boards 16 to 21. All of the tests conducted on the receiver passed.

32.4.2 *Systematic Artefacts in MBES Data*

Bathymetric data acquired by the EM302 during Leg 3 are extremely “noisy” (Figure 30.23). This is in part justified by the conditions under which it operates, namely heavy sea ice, rough seas, high speeds (12 to 14 knots) and extremes in depth. For instance, in Simpson Strait, between King William Island and the continent, we sailed in 11 m water depth, which is the upper limit of the EM302 range. Noisy data are, however, also acquired under optimal surveying conditions.

It is difficult to pin point the exact source of the noisy data. Tests have been conducted to eliminate interference between the numerous acoustic systems on board as a potential cause. For instance, during the survey of Sunneshine Fjord, both the EK60 and the Knudsen 3260 were stopped for several hours. Yet, noise in the MBES data remained ubiquitous.

One hypothesis is related to the malfunctioning of the TX; indeed, it appears the TX doesn’t consistently emit. This is interpreted from the Beam Intensity datagram as well as from the Water Column data in SIS (Figure 30.24). When TX intensity is low to inexistent, the RX picks up noise between sectors (side lobes?) as shown in .

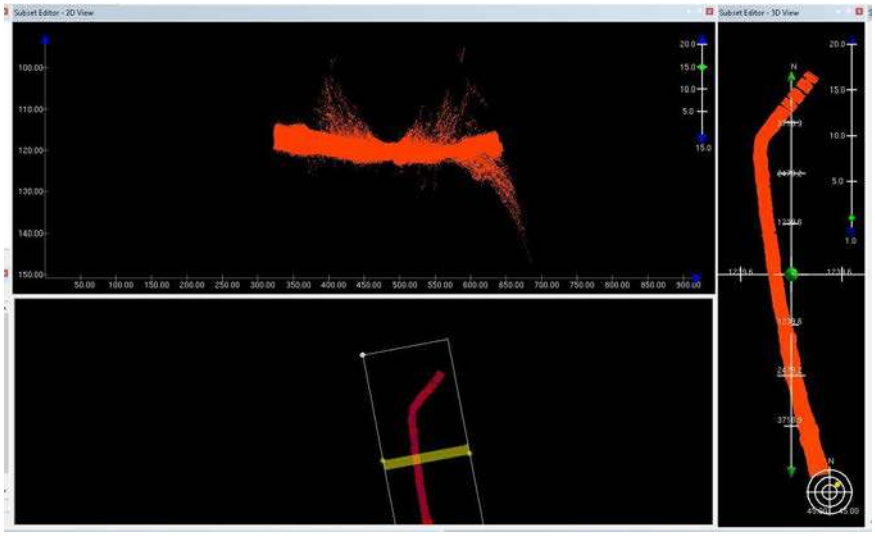

Figure 32-23 Example of systematic artefact in MBES data viewed in HIPS & SIPS Subset Editor.

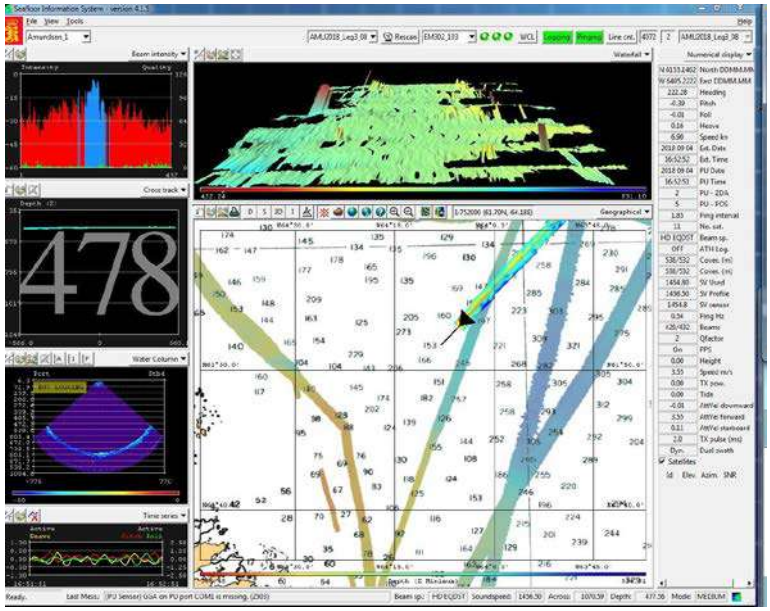

Figure 32-24 SIS interface during MBES data acquisition. Extremely noisy MBES data despite ideal survey conditions (7 knots, calm seas, fairly deep water). Notice the low beam intensity and the absence of sound in the water column.

32.4.3 *Outer Beams*

At the beginning of September, the degradation in data quality in outer beams was such that the swath angle for data acquisition was reduced to 55 degrees on both Port and Starboard sides, reducing the swath width to less than 3 times the water depth. This in turn increases the quality of the data within the 110 degree swath.

33 Integrated Marine Geoscience for Environmental Impact Assessment and Sustainable Development in Frobisher Bay, Nunavut – Leg 2c

Project leaders: Evan Edinger[1] (eedinger@mun.ca) and Linda Ham[2]
Cruise participants – Leg 2c: Evan Edinger[1], Alec Aitken[3], David Côté[4], Vonda Wareham-Hayes[4], Barbara de Moura Neves[4] and Meghan Hamp[3]
[1] *Memorial University of Newfoundland, St. John's, NL, Canada*
[2] Canada-Nunavut Geoscience Office, Iqaluit, NU, Canada
[3] *University of Saskatchewan, Saskatoon, SK, Canada*
[4] *Fisheries and Oceans Canada, St. John's, NL, Canada*

33.1 Introduction

Coastal regions of the Canadian Arctic face increasing pressures from climate change, resource exploitation, and infrastructure development. These pressures come together in a crucial region of the Eastern Arctic (IRIS region 2) in Frobisher Bay. Situated adjacent to the rapidly growing City of Iqaluit, the bay faces potential impacts from expanding commercial and subsistence fisheries, increasing marine traffic, and infrastructure development for the City of Iqaluit.

Climate change is directly influencing circumpolar environments through rising air temperatures, which cause sea surface temperatures to rise, sea ice to melt, and sea levels to rise (IPCC 2011, McLaughlin et al. 2011). Surface air temperatures in the circumpolar North are currently rising at a rate twice that of the global mean air temperatures (Overland et al. 2017) and this has the potential to alter the Arctic marine environment (Dery et al. 2016). Frobisher Bay is experiencing similar long-term trends including warmer surface air temperatures, declining sea ice thickness, and a shortened ice cover season (Government of Canada 2018).

Superimposed on these changes in the marine environment of Frobisher Bay are the potential impacts of human-mediated activities. The inner bay is exposed to anthropogenic pollution related to plastic contamination from terrestrial activities in Iqaluit, and wind-blown debris from the Iqaluit dump or the 2015 dump fire. Infrastructure requirements for the City of Iqaluit place additional possible stressors on Frobisher Bay, from eutrophication, sedimentation, potential oil spills, and introduction of marine invasive species through ballast water. These various stressors may affect seabed habitats in the bay (Hatcher & Forbes 2015).

Scientific objectives of the project relating to 2018 field work

The general scientific objectives of the Frobisher Bay project are:

1) To create a benthic habitat map for all of Frobisher Bay using multibeam sonar and sub-bottom profiling, ground-truthed with direct benthic sampling.
2) To develop maps of hazards and of sensitive habitats for application toward infrastructure development in the Frobisher Bay region.
3) To measure environmental contamination from Iqaluit in marine sediments and surface waters of inner Frobisher Bay.

The sampling objectives for the 2018 research program aboard CCGS *Amundsen* were:

1) to map a small polygon east of the middle islands (Figure 31.1) and a deep trough along the southern coast of the outer bay that is too deep to be mapped using the less powerful sonar aboard MV Nuliajuk (Figure 31.2);
2) to sample and film areas of varying depth and slope in the outer bay to characterize seabed habitats and benthic macrofauna;
3) to collect baseline data on surface microplastic concentrations in inner and outer Frobisher Bay;
4) to collect sediment cores (i.e., stations Bell 9 and Bell 10) with which to assess hydrocarbon contamination from ships in Frobisher Bay sediments.

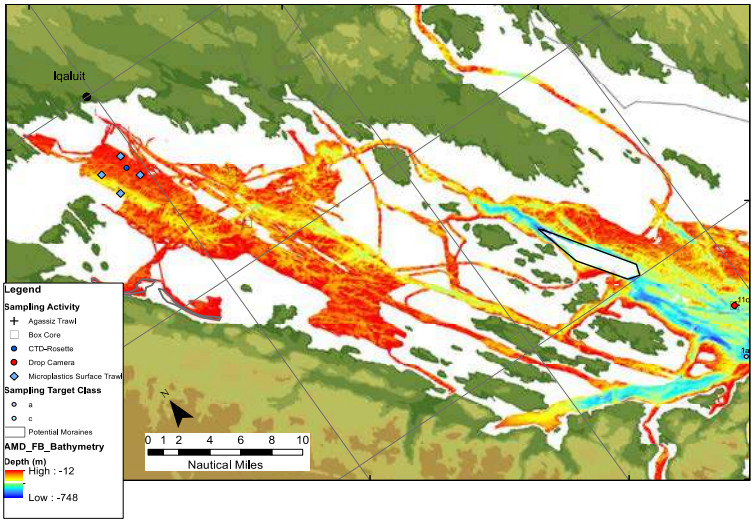

Figure 33-1 Sampling locations in inner Frobisher Bay onboard the CCGS *Amundsen*, July 25-27, 2018.

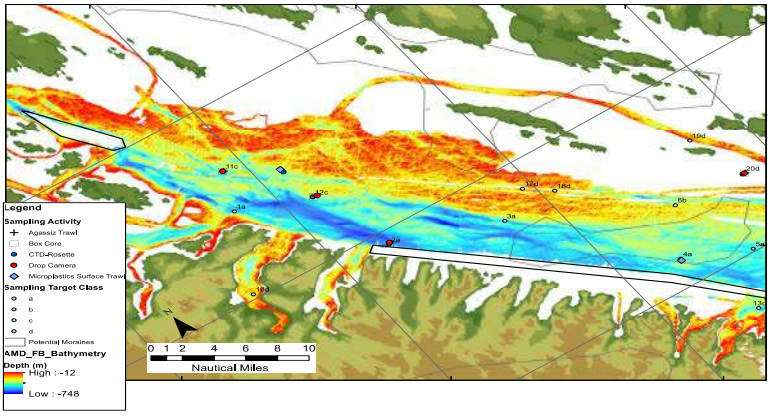

Figure 33-2 Sampling locations in outer Frobisher Bay onboard the CCGS *Amundsen*, July 25-27, 2018. Thick black polygons indicate approximate boundaries of areas mapped during the 2018 Amundsen expedition. The long swath along the southern boundary of outer Frobisher Bay was mapped first in Leg 2a (1 swath), then on Leg 2c (a second swath).

33.2 Methodology

Methods employed during the Frobisher Bay portion of Leg 2c included seabed mapping with multibeam sonar and 3.5 kHz acoustic sub-bottom profiling, deployment and testing of a new deep-water camera for filming seabed habitats and benthic fauna in waters deeper than 200 m, box coring, Agassiz trawling, CTD/rosette casts, and surface trawling for microplastics. Figure 31.1 and Figure 31.2 show the locations of all box cores, Agassiz trawls, CTD/rosette casts, surface microplastics trawls, and multibeam data collected in inner and outer Frobisher Bay, respectively.

33.2.1 *Seabed Habitat Mapping*

Sampling from CCGS *Amundsen* in 2018 aimed to sample deeper water sites in the outer bay that are beyond the depth range attainable from the MV Nuliajuk. Box core and Agassiz trawl sampling in outer Frobisher Bay support our efforts to map seabed habitats throughout the bay. Sampling targets for ground-truthing the multibeam sonar data were defined using the ISO cluster algorithm and maximum likelihood classification of the multibeam sonar data based upon depth, slope, and bathymetric derivatives such as the benthic position index (BPI), which uses relative position to separate bathymetric highs (ridges and pinnacles) from lows (troughs and depressions). Four bottom type classes were identified (labeled a-d) and placed five sample sites randomly within each class. Lacking knowledge on seabed habitats in the outer bay, this plan increases the chances of sampling a range of habitat types. Direct sampling was to include one box core sample per station, and one Agassiz trawl sample for each class of bottom type, coupled with sub-bottom profile acquisition and drop-camera surveys at each station.

33.2.2 *Drop-video Surveys*

The drop video camera used was the new DFO-NL SubC Mark 6 high-definition 4K video camera with built-in laser pointers and high-illumination LED light, deployed from an old box-core tripod inside the “Frankenbox” (Figure 31.3). This deployment system protects the camera and battery inside an old box-corer sampling box into which have been welded supports for the camera, battery and light, and bars to protect the camera and battery in the event that the box should strike a rock. Furthermore, the box was modified to orient the camera at a 30 degree angle to vertical, facing forwards. The light is attached to one of the forward-facing box-corer tripod legs. The rear-facing box-corer tripod leg has had a fin, composed of a 60 cm x 35 cm piece of plexiglass, bolted to three steel supports welded to the tripod leg.

The drop camera was deployed mostly in yo-yo mode, with the camera lowered to the seabed, and then raised 1 to 2 metres off the seabed using the ship’s main sampling winch, then lowered again to find the seabed, in case the seabed depth had changed. The ship was allowed to drift with the wind or tide for 15 minutes with the camera recording continuously during this time, generally touching the bottom 1 to 5 times per minute. The depth and position of the drop camera were monitored using an acoustic beacon linked to the ship’s new HiPAP high-precision navigation and tracking hardware (Table 31.1).

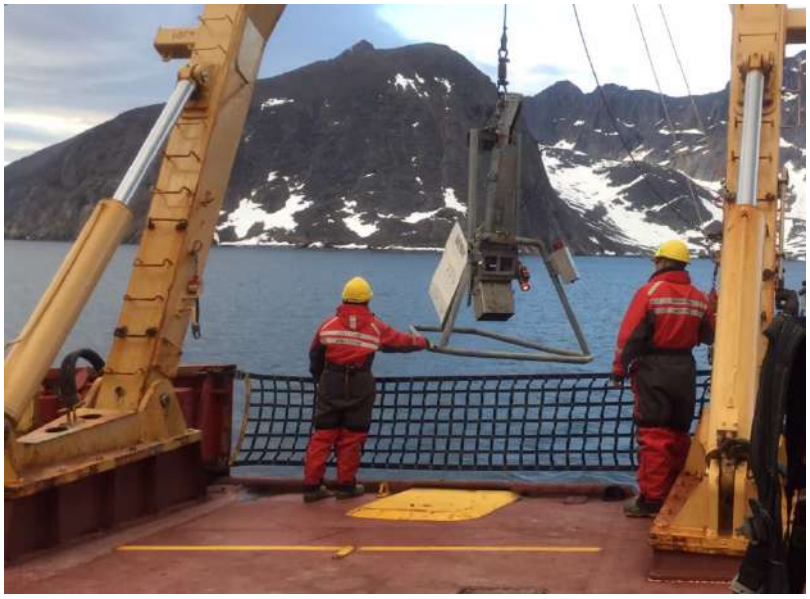

Figure 33-3 . DFO (NL) drop video camera, the “Frankenbox”, being deployed in outer Frobisher Bay. Photo © David Coté.

33.2.3 *Box Cores*

Eight box cores were collected and processed in Frobisher Bay (Table 31.1). Two box cores were acquired in inner Frobisher Bay at stations Bell 9 and Bell 10. These were sampled as two push cores each, of which one was kept intact for analysis of stratigraphy and contaminants for C-NGO, and the other was sectioned for depth-stratified analysis of hydrocarbon contaminants. In outer Frobisher Bay, six box cores were collected to sample bottom types and faunas across gradients of depth and slope, based on multibeam bathymetry. A 3.5 kHz sub-bottom profile was recorded at each of the outer bay box-coring sites, and archived in .jpg and .jp2 format. The corer was damaged by contact with stones at station 7b: coring ceased to allow for repairs. The remaining sample locations in outer Frobisher Bay were surveyed using the sub-bottom profiler only (site 6b), or using the drop-video camera and sub-bottom profiler (sites 9b, 10b, 15c). Sediment samples from each box core were frozen at -20˚C for later processing to determine sediment texture (% gravel, % sand, % mud) and organic carbon content. These data will support benthic habitat characterization. Macrofauna recovered in box cores were picked from 0.5 mm sieved sediment, fixed in 10% formalin, and then transferred to 70% ethanol after 72 hours.

33.2.4 *Agassiz Trawls*

The Agassiz trawl was deployed at outer bay stations 11c and 20d: we had planned for one trawl in each of the four bottom types (Table 31.1). Agassiz trawling was suspended after wind-speeds exceeded 25 kt on the afternoon of 26 July. Macrofauna recovered in Agassiz trawls were picked from 1.0 mm sieved sediment, fixed in 10% formalin, and then transferred to 70% ethanol after 72 hours.

Table 39-1 Box core, Agassiz trawl, and drop video camera stations occupied in Frobisher Bay, July 25-27, 2018.

Station	Date	Latitude	Longitude	Depth (m)	Box Core	Agassiz Trawl	Drop Camera
Bell 9	July 25	63.5378	-68.38102	88.79	X		
Bell 10	July 25	63.59424	-68.33455	97.19	X		
11c	July 25	63.16525	-67.55131	369.72	X	X	X
12c	July 26	63.08111	-67.42798	345	X		X
2a	July 26	62.98103	-67.37234	596	X		X
13c	July 26	62.68646	-66.7702	225	X		X
20d	July 26	62.84452	-66.58889	112.56	X	X	
7b	July 26	62.73346	-66.57315	445.2	X		
9b	July 26	62.67519	-66.4908	498			X
10b	July 27	62.65593	-66.39952	385			X
15c	July 27	62.43127	-65.88545	333			X

33.2.5 *CTD – Rosette Casts*

CTD and rosette casts were performed at 6 locations, constituting a transect from the head of the bay to the centre of the outer bay, to characterize the physical and chemical properties of water masses within the bay: temperature, salinity, and oxygen saturation. Instrumental data were collected throughout the bay, and water samples were collected at several stations in the outer bay for the GENICE project. In addition, water samples were collected at station 9b, the deepest station in the outer bay, to analyze for total alkalinity, dissolved inorganic carbon, dissolved carbon dioxide, and dissolved methane, allowing for calculations of calcium carbonate saturation profiles and methane concentrations (cf. Azetsu-Scott et al. 2010, Punshon et al. 2014; Table 2). Samples were poisoned with a HgCl2 solution, and stored in glass bottles within padded boxes in the aft refrigerated container. Samples will be analyzed by Dr. Kumiko Azetsu-Scott at the Bedford Institute of Oceanography.

Table 39-2 Water samples collected for calcium carbonate saturation state in Frobisher Bay during Leg 2c, July 25-27, 2018.

Station	Date	Latitude	Longitude	Purpose of water sampling
Nutrient	July 25	63.66146	-68.53889	Instrumental profiles for T, S, O_2
Outer Bay A	July 25	63.12759	-67.43903	GENICE
12c Nutrient	July 25	63.08161	-67.42867	GENICE
13c Nutrient	July 26	62.68665	-66.77247	GENICE
20d Basic	July 26	62.84429	-66.59396	GENICE
9b	July 26	62.67417	-66.49068	$CaCO_3$ chemistry, pCO_2, CH_4, GENICE

33.2.6 *Surface Microplastics Trawls*

Sampling for surface microplastics by Network Investigators Neves and Wareham-Hayes involved deployment of a Manta seston trawl with ~200 m mesh net at the sea surface (Figure 31.4) for four replicate 30-minute trawls at maximum speed of 3 kt. Trawls were conducted at 2.8 kt., with sampling targets near Iqaluit, and in the outer bay. The four transects near Iqaluit

were sampled close to the area where cargo ships anchor while unloading cargo. The four transects in the outer bay were spread among 3 locations in the outer bay, and are intended to capture microplastics washed in from the northwest Labrador sea, or released from passing ships (Table 31.3). Although the distance between replicate trawls in the outer bay is greater than the distance between replicate trawls in the inner bay, the replicates in the outer bay are meant to characterize a greater area.

Table 39-3 . Location of microplastic Manta surface trawls in inner and outer Frobisher Bay during Leg 2c, July 25-27, 2018.

Transect	Date	Time (Start)	Latitude (Start)	Longitude (Start)	Time (Finish)	Latitude. (Finish)	Longitude (Finish)
1 (inner)	July 25	8:42	63.64688	-68.52211	9:13	63.66949	-68.53215
2 (inner)	July 25	9:25	63.6757	-68.53406	9:56	63.67049	-68.58581
3 (inner)	July 25	10:06	63.67017	-68.59811	10:37	63.6478	-68.58768
4 (inner)	July 25	10:45	63.64192	-68.58663	11:16	63.6466	-68.53474
Outer Bay A	July 25	22:07	63.1326	-67.44065	22:38	63.10938	-67.43617
13c	July 26	11:12	62.68736	-66.77094	11:42	62.70509	-66.74814
4a	July 26	18:06	62.78516	-66.86171	18:09	62.78428	-66.85693
8 (outer)	July 27	4:25	62.43105	-65.89501	4:56	62.40909	-65.91366

Figure 33-4 Manta trawl for surface microplastics under deployment in Frobisher Bay.

33.3 Preliminary Results

33.3.1 *Multibeam Sonar Acquisition*

CCGS *Amundsen* acquired multibeam sonar data during a 3-hour dedicated survey in the northwest portion of outer Frobisher Bay, in waters that were too deep to be reached by the MV Nuliajuk (i.e., bounding co-ordinates: 63.261/-67.727; 63.185/-67.517; 63.184/-67.686; 63.252/-67.772; Fig. 2). A narrow corridor of intermediate depth water at the north end of this polygon remains unsurveyed, but can probably be filled by the MV Nuliajuk. The gap in multibeam coverage along the deep but uncharted southwest margin of the outer bay was partially filled using two along-track passes of the ship at 50% overlap, thus ensuring that the ship was never sailing in areas from which no bathymetric data were available.

33.3.2 *Ground-truthing of multibeam sonar seabed classification using the drop video camera, box coring and Agassiz trawls*

The 2018 sampling sites in the outer bay were selected along gradients of depth and slope, but also corresponded to some degree with potential submerged moraines mapped by the Canada-Nunavut Geoscience Office, based on extrapolations from moraines observed above the water line. The drop video camera acquired seabed imagery at stations seven stations in the outer bay (Figure 35.5). Bottom types ranged from sandy mud to cobble-boulder gravel. As shown by the range of bottom types indicated in class c stations, the unsupervised classification of the multibeam sonar data based on bathymetry and bathymetric derivatives does not translate readily into a bottom type gradient based on grain size. CCGS *Amundsen* multibeam backscatter data are not sufficiently reliable to use as a descriptor of bottom type. Better acoustic backscatter data (i.e., as available from MV Nuliajuk) may help to resolve this uncertainty.

The morphology of exposed bedrock on the seafloor is evident in multibeam sonar backscatter data (Mate et al. 2014, Todd et al. 2016). A thin veneer of coarse-grained glacially deposited or postglacial sediments covers these bedrock surfaces (Figure 35.6). Rock clasts recovered from these sediments were polymict (Figure 35.7), with clast shapes ranging from highly angular to subrounded (Table 35.4) that are characteristic of subglacial till deposits. The occurrence of carbonate rock clasts in sediment recovered at station 20d is intriguing, given the abundant carbonate clasts recorded in glacial deposits along the northeast margin of Frobisher Bay, and the outcropping of Paleozoic carbonates within the outer portions of outer Frobisher Bay (Miller 1980; Mate et al. 2014). Several carbonate clasts show dramatic evidence of macroscopic bioerosion and corrosion (Figure 35.7). Living specimens of the bivalve Hiatella arctica were observed boring into several of the carbonate clasts.

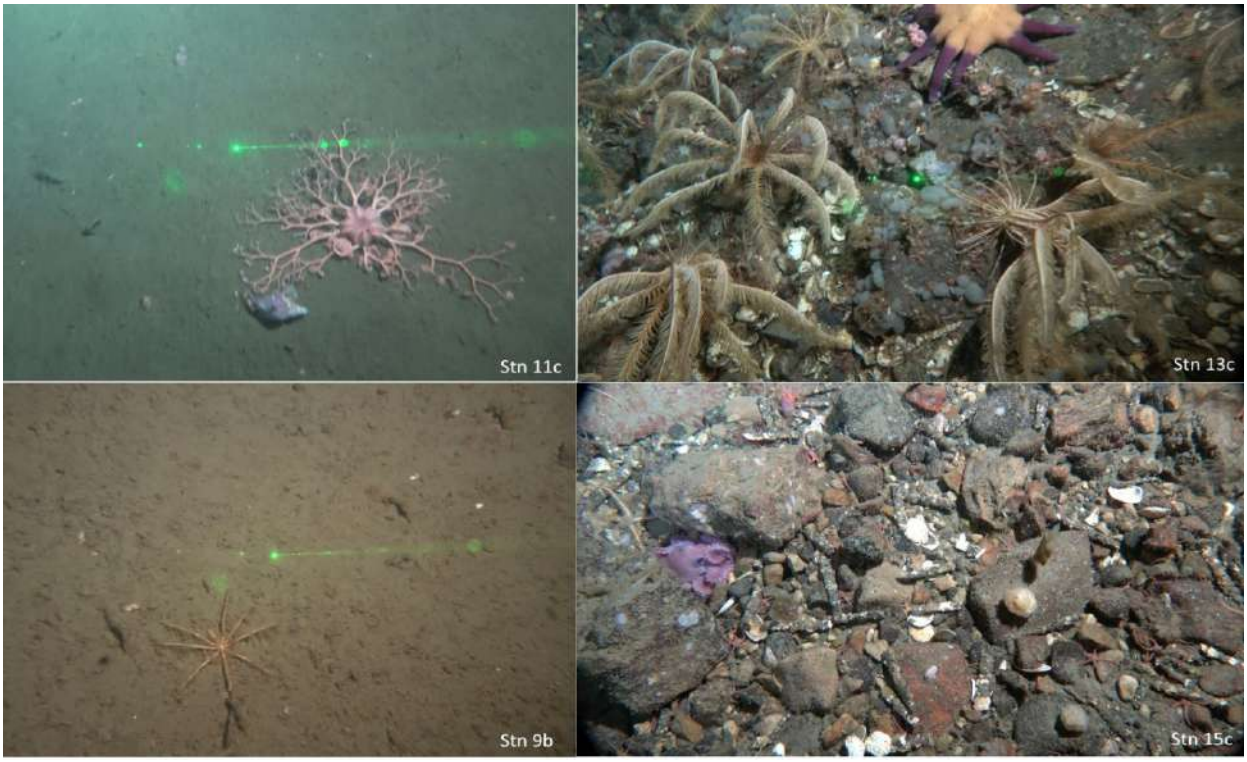

Figure 33-5 . Drop video camera still images of bottom types and fauna observed in outer Frobisher Bay. Four stations are represented, of which three were in bottom class c, but nonetheless represented quite different bottom types. Lasers 6.25 cm apart. Note the octopus, Bathypolypus arcticus (centre left), at station 15c. Video data will be analyzed for both bottom type and fauna to prepare a revised classification of Frobisher Bay multibeam sonar. Images © Dave Coté, DFO-NL.

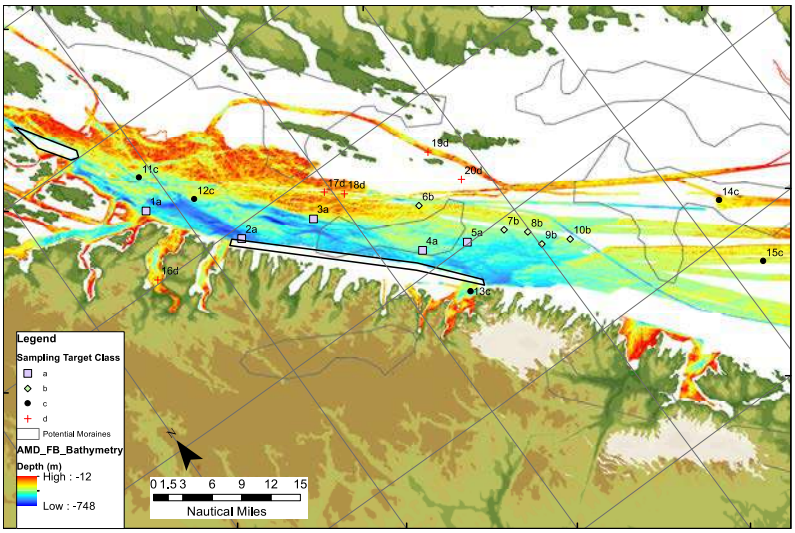

Figure 33-6 Map of seabed classes targeted for sampling within outer Frobisher Bay in waters > 200 m depth, based on unsupervised classification of bathymetry and bathymetric derivatives. Black polygons indicate additional areas mapped during AMD2018 expedition.

Figure 33-7 Rock clasts recovered from the box core at station 20d. Note the abundant polymict pebbles and cobbles (left), and bioerosion in carbonate clasts (right).

Table 39-4 Rock clast shapes. Data are reported as the number of clasts in each shape class.

Station	Sample	Very Angular	Angular	Subangular	Subrounded
13c	Box core	19	10	10	0
20d	Box core	9	16	17	0
20d	Agassiz trawl	5	3	7	6
7b	Box core	2	13	6	5

33.3.3 *Marine Fauna*

Sediments and macrofauna from outer bay sites apparently vary according to slope, as expected, with coarser sediments and more abundant epifauna found at sites with steeper slopes. Observations on the organisms recovered in box cores and Agassiz trawls are presented in Table 35.5, Table 35.6 and Table 35.7. Errant polychaetes (e.g., Nereis sp.), tubiculous polychaetes (e.g., maldanid, onuphid), bivalves (e.g., Hiatella arctica), and ophiuroid echinoderms (e.g., Ophiura sarsi) are well represented in the macrofauna recovered in box cores (Table 35.5). Echinoderms (Gorgonocephalus sp., Ctenodiscus crispatus), errant polychaetes (Nephthys sp.), amphipods (Anonyx sp.) and priapulids (Priapulus sp.) occur abundantly in the macrofauna recovered in the Agassiz trawl at station 11c (Table 31.6). Echinoderms (Heliometra glacialis, Strongylocentrotus droebachiensis), soft corals (Drifa glomerata, Gersemia sp.), sponges, and crustaceans (Lebbeus polaris) occur abundantly in the macrofauna recovered in the Agassiz trawl at station 20d (Table 31.7).

Table 39-5 CCGS *Amundsen* Leg 2c, July 25 to July 27, 2018: Marine invertebrates recovered in box cores.

Species	2a	7b	11c	12 c	13c	20d
Errant polychaetes	X		X		X	
Nereis sp.				X		X
Onuphid polychaetes			X	X	X	X
Maldanid polychaetes		X	X	X		

Tubiculous polychaetes		X	X	X		
Amphipods			X			
Malacostraca			X			
Astarte crenata						X
Colus sp.			X			
Cylichna sp.	X		X			
Ennucula tenuis	X			X (dead)		
Portlandia arctica	X					
Hiatella arctica		X	X		X	X
Limpets					X	X
Macoma calcarea	X				X	X (dead)
Mya truncata						X (dead)
Nuculana pernula		X				
Siphonodentalium sp.		X (dead)				
Tachyrhyncus reticulata					X	X
Thyasiirid bivalves			X			
Yoldia hyperborea	X		X	X (dead)		
Asteroidea				X		
Ctenodiscus sp.			X			
c.f. *Stephanasterias albula*						X
c.f. *Cucumaria frondosa*						X
Ophiuroidea	X		X	X	X	
c.f. *Amphieura sundevalli*					X	
Gorgonocephalus sp.					X	
Heliometra sp.						X
c.f. *Ophiura sarsi*					X	X
c.f. *Ophiopleura borealis*	X					
c.f. *Ophiocten sericeum*	X					
c.f. *Ophiopholis aculeata*						X
Strongylocentrotus droebachiensis						X
? Priapulids			X			
Sponge			X			
Bryozoans					fragments	
Arenaceous forams		X				

Table 39-6 CCGS *Amundsen* Leg 2c, July 25-27, 2018: Marine invertebrates recovered in Agassiz trawl samples. Station 11c, July 25, 2018

Species	Identified onboard		Retained for ID		Retained for isotopes	
	# ind	Biomass (g)	# ind	Biomass (g)	# ind	Biomass (g)
Cerianthidae spp.					4	29.87
Ophiocantha bidentata					2	8.47
Anonyx sp.					25	6.69
Cumacea spp.					3	1.31
Amphipoda spp.					2	0.7
Musculus niger					1	3.02

Boreotrophon clathratus					1	2.2
Pectinaria granulata					5	9.96
Brada inhabilis					4	5.95
Porifera spp.					1	25.42
Colonial tunicates					n.d.	9.72
Henricia sp.					1	1.08
Ophioscolex glacialis					1	2.36
Priapulus sp.					8	28.58
Anisarchus medius					1	13.07
Ctenodiscus crispatus					4	63.31
cf. *Lebbeus* sp.					1	9.02
Gorgonocephalus sp.					2	234.29
Boreonymphon sp.					3	4.25
Nephthys sp.					9	31.58
Cerianthidae spp.					3	16.58
Onuphidae sp.					10	35.02
Gorgonocephalus sp.					1	336.47
Colus sp.	1	5.6				
Total		5.6				878.92

Table 39-7 CCGS Amundsen Leg 2c, July 25-27 2018: Marine invertebrates recovered in Agassiz trawl samples. Station 20d, July 26, 2018.

Species	Identified onboard		Retained for ID		Retained for isotopes	
	# ind	Biomass (g)	# ind	Biomass (g)	# ind	Biomass (g)
Strongylocentrotus sp.					11	221.27
Sclerocragnon ferox					1	9.33
Fish 1					3	17.57
Fish 2 (cf. *Anisarchus medius*)					2	6.21
Fish 3					1	24.24
Rossia sp.					1	21.12
Stegocephalus sp.					8	10.58
Stegocephalus sp.					1	0.22
Sponge 1					1	4.92
Heliometra glacialis					5	145.87
Lophaster furcifer					2	131.56
Tunicata sp.1					1	13.35
Lebbeus polaris					15	37.91
Crossaster sp.					2	7.16
Polychaeta sp. 1					1	1.41
Nemertina sp. 1					1	8.45
Jellyfish 1					1	7.07
Terebellidae sp. 1					1	2.76
Maldanidae sp. 1					3	18.21

Gorgonocephalus sp.					3	200.86
Ophiuroidea					2	9.21
Gastropoda 1 (cf. *Margarites* sp.)					3	5.56
Arcturus sp.					1	0.34
Tunicata sp. 2					1	11.34
Ophiocantha bidentata					8	11.37
cf. *Stegophiura nodosa*					30	7.24
Drifa glomerata					2	50
Gersemia sp.					2	21
Henricia sp.	4	1.01				
Boreonymphon sp.	1	1				
Drifa glomerata	16	316				
Gersemia sp.	22	145				
Bryozoa	fragments	28				
Sponge	1	9				
Sponge	1	182.27				
Sea anemone	2	13.33				
Hemithyris sp.	1	1.77				
Bryozoa	2	1.27				
Gorgonocephalus sp.	3	362.53				
Heliometra sp.	1	18.22				
Sponge	1	283.57				
Heliometra sp.	n.d.	4782.59				
Ophiuroidea			n.d.	51.35		
Ophiuroidea			n.d.	66.26		
Gorgonocephalus sp.			4	6.41		
Hiatella arctica			1	13.85		
Natica sp.			2	2.10		
Astarte crenata			1	5.90		
Starfish			1	0.40		
Strongylocentrotus sp.			78	1220.57		
cf. *Eualus gaimardii*			2	2.52		
Total		6145.56		1369.36		71

Specimens retained for isotopic analysis by Gustavo Guarin (U. Laval).
Specimens retained for ID by Alec Aitken (U. Saskatchewan).
Sponge/coral identifications provided by Barbara de Moura Neves (DFO-NL).

33.3.4 *Water Sampling*

Below the surface layer (T > 0°C, S < 32 psu) evident in all stations, the deep station in the outer bay shows a pronounced temperature minimum in the 150-350 m depth range (Figure 31.8),

which may restrict some of the regional sub-arctic fauna such as most Labrador Sea cold-water corals other than the common nephtheid soft corals. Sponges appear to be un-restricted by the cold bottom water temperatures (Dinn et al., submitted). Aragonite and calcite saturation state calculations from two CTD casts in Frobisher Bay in 2016 suggest that inner Frobisher Bay waters shallower than 100 m are slightly saturated with respect to both carbonate species (Punshon, unpublished data, cited in Zammit, 2017).

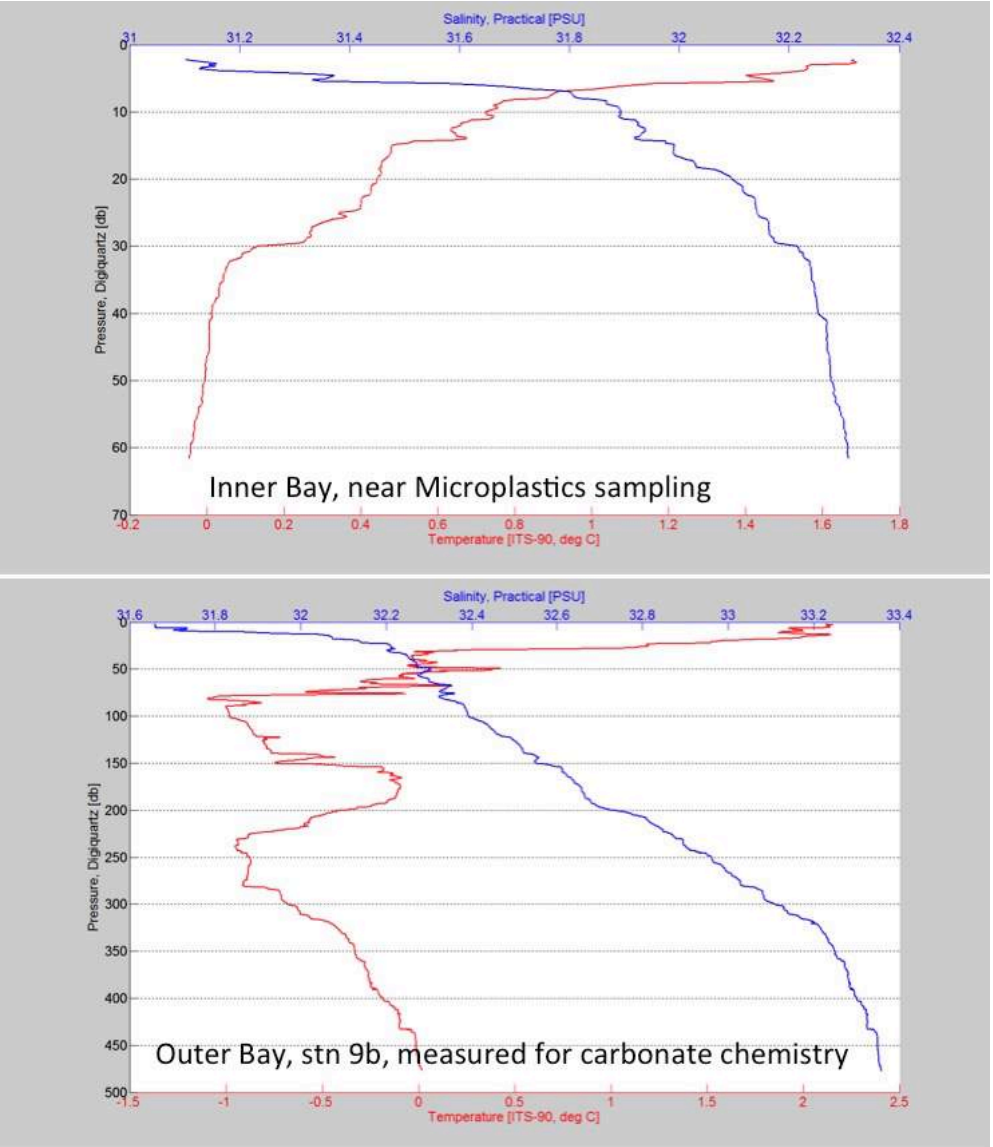

Figure 33-8 Temperature and salinity profiles from CTD/rosette casts in Frobisher Bay. The y-axis, indicated as pressure (dB), is broadly representative of water depth. Water samples were taken at standard depths in the deep outer bay cast at station 9b, for measuring carbonate chemistry, dissolved CO_2, and dissolved CH_4, with the goal of calculating aragonite and calcite saturation.

33.4 Acknowledgement

We thank Shaomin Chen (Dalhousie U.) and Karl Purcell (UQAM) for collecting water samples to assess carbonate saturation in Frobisher Bay, and hydrographic intern Luca Arduini Plaisant (Amundsen Science) for collecting and processing multibeam and sub-bottom profile data throughout the bay. Vonda Wareham-Hayes (DFO-NL), Barbara de Moura Neves (DFO_NL), Meghan Hamp (U. Sask.), Fatma Dhifallah (UQAR), Bodil Lauridsen (Geological Survey of Greenland), Camilla Parzanini (Memorial U.), and Gustavo Adolfo Guarin (U. Laval) assisted with the processing of the box core and Agassiz trawl samples acquired in Frobisher Bay. Catie Young and Andrew Murphy assisted with the deployment of the drop video camera. We thank Chief Scientist Philippe Archambault, Captain Claude LaFrance, and the crew of CCGS *Amundsen* for their dedicated support of our research in Frobisher Bay.

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34 U-Th Dynamics in Surface Sediments, and Silicon Isotope Dynamics in Sponges of the Eastern Canadian Arctic – Leg 2c

Project leader: Claude Hillaire-Marcel[1] (hillaire-marcel.claude@uqam.ca)
Cruise participant – Leg 2c: Karl Purcell[1]
[1] *Département des Sciences de la Terre et de l'Atmosphère, Université du Québec à Montréal, Montréal, Qc, Canada*

34.1 Introduction

The Uranium radioactive decay chain contain isotopes of many elements. The geochemical properties of these elements are diverse and cause fractionation according to the physical and chemical conditions. The isotopic analysis of this decay chain allows a reconstitution of the transport and accumulation processes of these elements. My work uses the analysis of 230Thxs to give age constraints to sediments and allow the determination of sedimentation speeds. This technique goes up to ≈ 300ka and is particularly useful in the central artic ocean where very low sedimentation rates and biological remains make other techniques difficult to apply.

34.2 Methodology

34.2.1 *Sediment Sampling*

Surface sediments

This operation was done with the box core. After the core is brought back on board, a spatula is used to collect around 30g of sediment which is then put into a plastic bag. The bag is sealed and stored in a refrigerated lab.

Figure 34-1 Box Core

Push cores

This operation was done with the box core. After the core is brought back on board, a push core is inserted into the sediments with the help of a vacuum pump. The core is sealed and stored in a refrigerated lab. These samples and the surface sediments are intended to be analysed for the isotopic composition of the U-Th decay chain after they are shipped back to Geotop/UQAM.

Figure 34-2 Push Core Recovery

34.2.2 *Work on other projects*

Water sampling

Sea water samples were taken by the CTD Rosette for various analyses:

- TIC/TA, pCO_2/CH_4 (Owen Sherwood, Kumiko Azetsu-Scott). Both of these samples were taken, poisoned with mercuric chloride, then stored in a refrigerated container.
- Nutrients (Cara Manning) The water was filtered and stored in 15ml conical tubes, then frozen.
- NO_3 isotopes (Owen Sherwood) The water was sampled in small plastic bottles and kept in the dark after sampling, then frozen.

Geotop/UQAM sponge Si isotopes

Sponges were collected with the ROV, and the Agassiz trawl. Pictures are taken of the whole specimen, then a subsample a few cm^3 in volume is taken. The sample is put in a bag then frozen at -20°C. These samples are intended to be analysed for their silicon isotopic composition after they are shipped back to Geotop at UQAM.

ATLAS sponge Si isotopes

3 subsample are taken and put into a falcon tube. One tube is filled with ethanol, the other with formaldehyde, and the third tube is left free of chemical and frozen. These samples will be used

to compare the 3 different preservation methods before analysing the silicon istotopic composition by ATLAS.

ATLAS sponge transcriptomics

2-3 subsamples are taken and put into a Falcontube, then submerged with 3-4 ml of RNAlater, and preserved by freezing at -20°C. These samples will later be used to for transcriptomics analysis by ATLAS.

Figure 34-3 ROV collected sponge

34.2.3 *Collected Samples*

Table 40-1 Sediment samples

Sample Type	Station	Position	Depth	Date
Surface sediments	DFO-5	60.46839 N, 60.5849 W	1424 m	02/08/2018
Surface sediments	DFO-7	60.4759 N, 60.3751 W	1899 m	03/08/2018
Surface sediments	DFO-8	60.46749 N, 59.2441 W	2445 m	03/08/2018
Surface sediments	Disko Fan 6	67.97248 N, 59.5031 W	906 m	11/08/2018
Push core	Disko Fan 6	67.97248 N, 59.5031 W	906 m	11/08/2018

Table 40-2 Sponge samples

Station	Number of sponges	Position	Depth	Date

9b (Agassiz Trawl)	1	62.6736 N, 66.4882 W	500 m	26/07/2018
DFO-750 (Agassiz Trawl)	3	60.48107 N, 61.2095 W	799 m	01/08/2018
Hatton basin (ROV)	1	61.44661 N, 60.7101 W	625 m	05/08/2018
Scott Inlet (ROV)	2	71.22734 N, 70.0435 W	257 m	12/08/2018

35 Collecting Sedimentary Record and Dinoflagellate Samples in Baffin Bay – Leg 2c

Project leader: Patrick Lajeunesse[2] (patrick.lajeunesse@grr.ulaval.ca)
Cruise participant – Leg 2c: Fatma Dhifallah[1]
[1] *Institut des sciences de la mer, Université du Québec à Rimouski, Rimouski, QC, Canada*
[2] *Département de géographie, Université Laval, Québec, QC, Canada*

35.1 Introduction

The sampling undertaken during this expedition is framed within the IRIS 1 targeted research from the ArcticNet Phase 4 funded project Mapping of Arctic Canada's Seafloor: Contributions to Global Change Science, Sustainable Resource Development, Safe Navigation of the Northwest Passage, Geohazards and Arctic Sovereignty (project leader: Patrick Lajeunesse).

Benefitting from the presence of the of the CCGS *Amundsen* in Baffin Bay during Leg 2C from Iqaluit to Resolute, the main objective of our team was the collection of multiple sediment cores and plankton samples in this areas in order to:

- Document the post-glacial melting history of the southern Greenland margin
- Reconstruct changes in sediment provenance and transport related to climate variability
- Document the evolution of primary and secondary productivity of the Canadian arctic ecosystem in relation with climate conditions
- Establish a deglacial/Holocene high-resolution magnetostratigraphy for the Canadian Arctic Ocean
- Identify and document the dinoflagellate communities living in Canadian Arctic

35.2 Methodology

The ISMER-UQAR team was responsible, together with Evan Edinger from Memorial University, for box and gravity coring operations. The multibeam echosounder (Konsberg Simrad EM300) and sub-bottom profiler (Knudsen 320R) were used, in collaboration with of Luca Arduini Plaisant (Amundsen Science), to ensure that the seabed was suitable for deployment of the corers, as well as to identify the thickest apparent Holocene sequences. Note that the Amundsen Science team was responsible for mapping the seabed morphology and in acquiring sub-bottom stratigraphy during this Leg.

35.2.1 *Plankton Sampling*

Dinoflagellates samples were taken from 14 sites with a 20 µm plankton net. At each site, a flow meter was fixed in the top of the net and a heavy lead weight at the down of the codend and then lowered vertically to the bottom.

After a couple of second, it was hauling back at a constant speed of 1m/s. The start, end number and ascend timing were recorded. The net was rinsed from top-down with a water of the site to

ensure that the entire organisms were in the codend. The concentrate of organism was transferred into a plastic jar and preserved with formaldehyde solution.

Figure 35-1 Plankton Sampling (1/2)

Figure 35-2 Plankton Sampling (2/2)

35.2.2 *Box Core*

The box corer collects up to 0.125 m3 of soft sediments at the seafloor and is suitable for any water depths (limited by winch cable length). It is used for minimum disturbance of the sediment/water interface. During the expedition, the box corer was deployed 4 times in the southern Basin Bay . When the sediment volume was sufficient, one push core (PVC tubes of 10 cm diameter and ~60 cm length) was taken from each box core using a vacuum pump to reduce compaction. The sediment/water interface from each box-core location was subsampled into several Ziploc bags for subsequent identification of microfossil (e.g., dinoflagellate cysts, non-pollen palynomorphs) as well as grain size, mineralogical, geochemical, magnetic analyses. Each push core and surface sediment sample was stored in a refrigerated container (4°C).

Figure 35-3 Box Core - AMD1802C-01BC

Figure 35-4 Box Core - AMD1802C-02BC

Figure 35-5 Box Core – AMD1802C-03BC

35.2.3 *Core Identification and Labelling*

The sediment core samples were labelled using the following numbering system:

AMD1802C-01BC
AMD = Amundsen
18 = Year 2018
02C = Leg # 02C
01 = Station # 1
BC = Corer type (box corer)

Plankton and core samples will be retained in refrigerated storage on the CCGS *Amundsen* during Legs 2C & 3 to be removed on demobilisation during September in Québec. These samples will then be shipped, and stored, and analysed in detail at Rimouski.

35.3 Preliminary Results

Considering the challenge to work in the Arctic Ocean due to rough sea conditions and sea ice extent, the mission was still successful with the collection of multiple sediments and plankton samples.

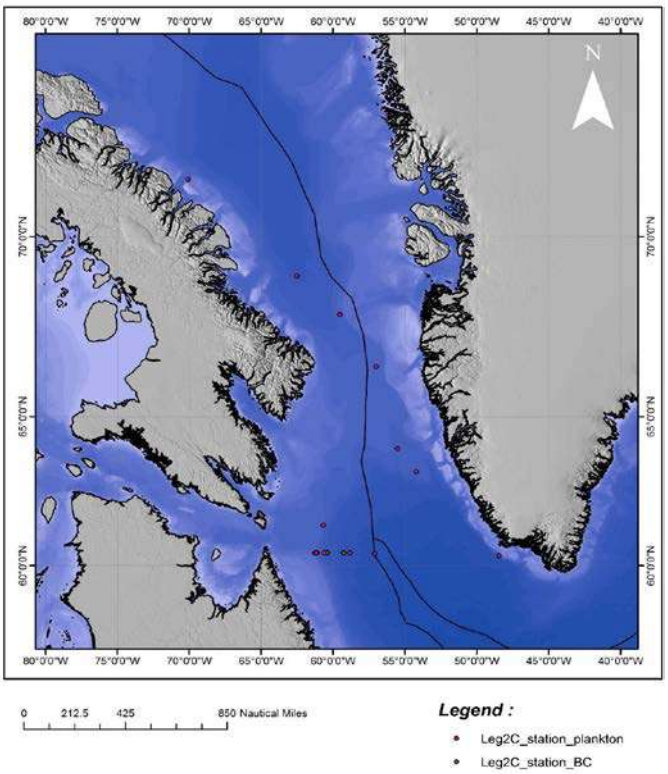

Figure 35-6 Location of the box cores and Plankton net collected from ISMER-UQAR team during the Leg 2c (Map: Luca Arduini Plaisant).

A total of 14 plankton net and 3 box cores were recovered at different locations along the Baffin Bay. These sediment cores samples will expand the sampled coverage area by the ISMER-UQAR team in the last years on board the CCGS *Amundsen*. Taken as a whole, these sediment cores samples will to provide an excellent surface coverage for a large part of the Canadian Arctic region which will allow us to have more confidence in our downcore interpretations.

These samples will be analyzed in detail in the laboratory to achieve the objectives of this mission. Briefly, sediment samples will be studied for their mineralogical (bulk and clay fraction), geochemical (elemental and isotopic), microfossil (dinoflagellate cysts, non-pollen palynomorphs), magnetic, and siliciclastic grain-size signatures. Such studies will provide a baseline to better interpret, in terms of sediment dynamics and climate change, the sedimentological signatures preserved in the Canadian Arctic sedimentary records, which may then help to place current eastern Arctic climate change.

Preliminary results are limited to direct observations of core penetration and sediments visible through the clear core-liner walls and exposed in box cores. In the Southern Baffin Bay, most of the surficial seabed sediments are predominantly composed of muddy and sandy sediments with relatively abundant benthic fauna.

For the plankton samples, the color (dark) of the concentrate of organisms decreases with the latitude.

Figure 35-7 Box core AMD1802C03BC

The time period covered by each core depends on the sediment accumulation rate at each location and that will be mainly determined following the paleomagnetic approach proposed by Barletta et al. (2008, 2010) and Lisé-Pronovost et al. (2009). This chronostratigraphic analysis will be performed in close collaboration with Guillaume St-Onge at ISMER-UQAR. The paleomagnetic age model will be improved by a combination of AMS-14C ages on mollusk shells and/or benthic foraminifers (when present) and 210Pb-137Cs measurements on the companion box-cores.

Finally, from a student and HQP-training perspective, the expedition was a unique opportunity for Fatma Dhifallah (MSc student at ISMER-UQAR) to receive hands-on training in coring operations and plankton sampling.

Table 41-1 Box Core Samples

Name	Station	Date - Hour (UTC)	Zone	Latitude N	Longitude W	Depth (m)	Push cores (cm)	Comment(s)
AMD1802C01A	DFO-3/Saglek deep	31 july 2018 à 4h45	Southern Baffin Bay	60.46958	-61.09302	1170	16.2	
AMD1802C02A	DFO-5	2 august 2018 at 10h40	Southern Baffin Bay	60.46839	-60.58490	1424	31	no sismique profil, beacon added to the boxcore
	DFO-7	3 august 2018 at 01h09	Southern Baffin Bay	60.47590	-60.37512	1887	N.A	Only surface sediment
AMD1802C03A	DFO-8	3 august 2018 at 17h37	Southern Baffin Bay	60.46771	-59.24516	2445	29	no sismique profil, beacon added to the boxcore

Table 41-2 Plankton Net Samples

Name	Station	Date -Hour (Québec)	Zone	Latitude N	Longitude W	Depth (m)	FMS	FME	Ascend time
AMD1802C01A AMD1802C01B	DFO-1/Saglek Bank	29 July 2018 at 19h55	SBB	60.46319	-61.26299	100	not recorded	not recorded	1min50
AMD1802C02A AMD1802C02B	DFO-3/Saglek Deep	30 July 2018 at 18h40	SBB	60.46944	-61.10021	100	67220	67246	1min50
AMD1802C03	DFO-750 au lieu DFO-2	31 July 2018 at 18h	SBB	60.47155	-61.22112	100	67247	67262	1min49
AMD1802C04	DFO-5	1 August 2018 at 22h	SBB	60.46654	-60.6041	80	67266	67272	1min47
AMD1802C05	DFO-9	3 August 2018 at 21h10	SBB	60.46907	-60.47016	100	67275	67314	1min50
AMD1802C06	DFO-11	4 August 2018 at 9h07	SBB	60.43904	-57.08450	100	67317	67373	2min
AMD1802C07	Hatton Basin	5 August 2018 at 3h43	SBB	60.43904	-57.0850	100	67374	67403	1min34

AMD1802C08	Lophelia	6 August 2018 at 22h10	SW	60.36743	-48.45822	94	67410	67428	1min44
AMD1802C09	NLSE07	9 August 2018 at 10h55	BB	63.24963	-54.20048	100	67429	67445	1min52
AMD1802C10	SW Greenland 1	9 August 2018 at 17h32	BB	63.99947	-55.50068	100	67445	67456	1min55
AMD1802C11	SW Greenland 2	10 August 2018 at 7h32	BB	66.49849	-57.00175	100	67456	67462	1min52
AMD1802C12	Disko Fan	10 August 2018 at 18h	BB	67.97671	-59.50735	100	67463	67468	1min52
AMD1802C13	SW Greenland 3	11 August 2018 at 10h04	BB	68.97616	-62.48286	100	67470	67480	2min13
AMD1802C14	Scott Inlet	13 August 2018 at 00h38	Baffin Island Coast	71.40847	-70.17733	100	67481	67464	1min52

NB: AMD1802C05 a wave has probably took part of the sample
FMS: Flow meter start
FME: Flow meter end

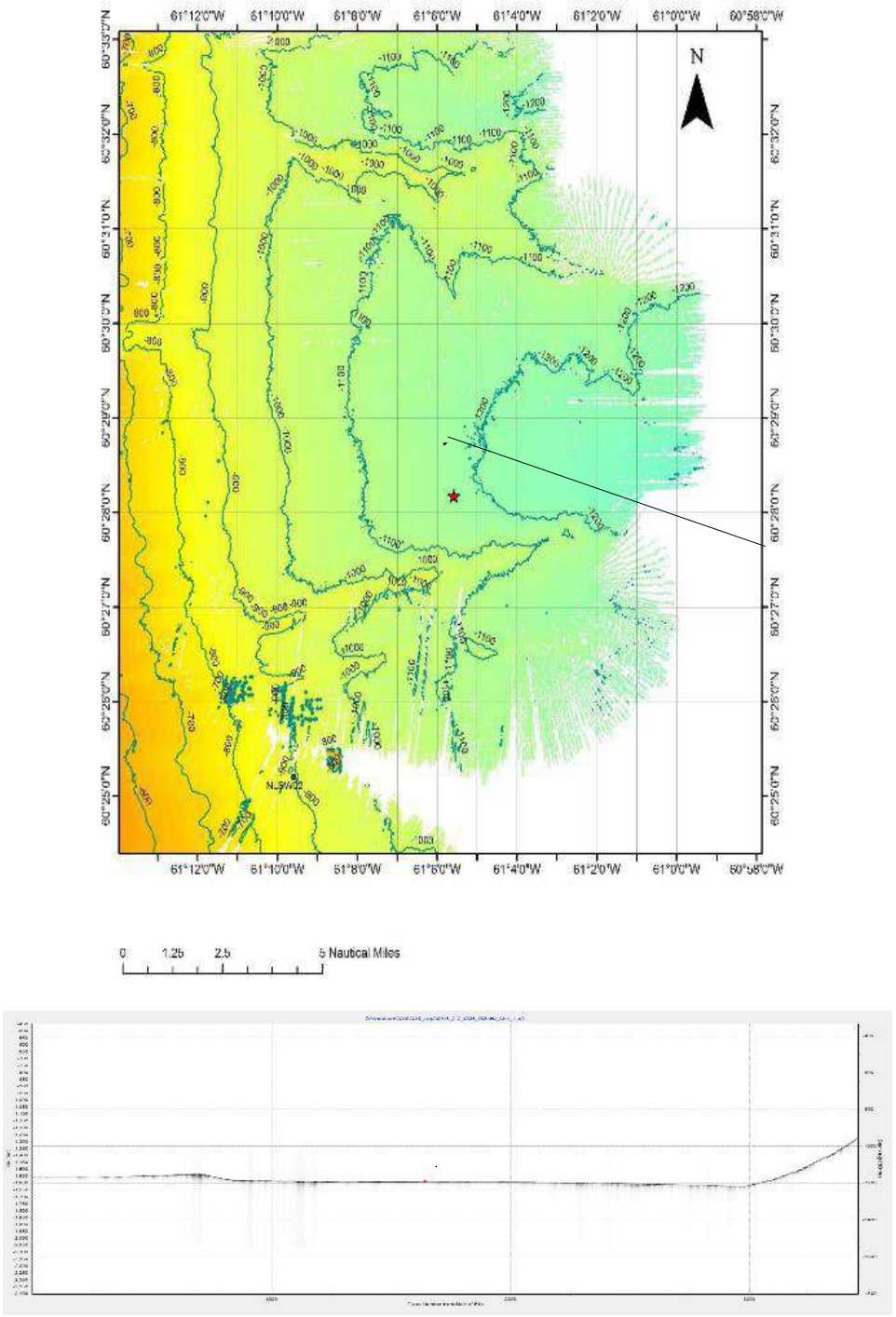

Figure 35-8 Sample Location on Seismic Profiles and Bathymetries (AMD1802c01BC)

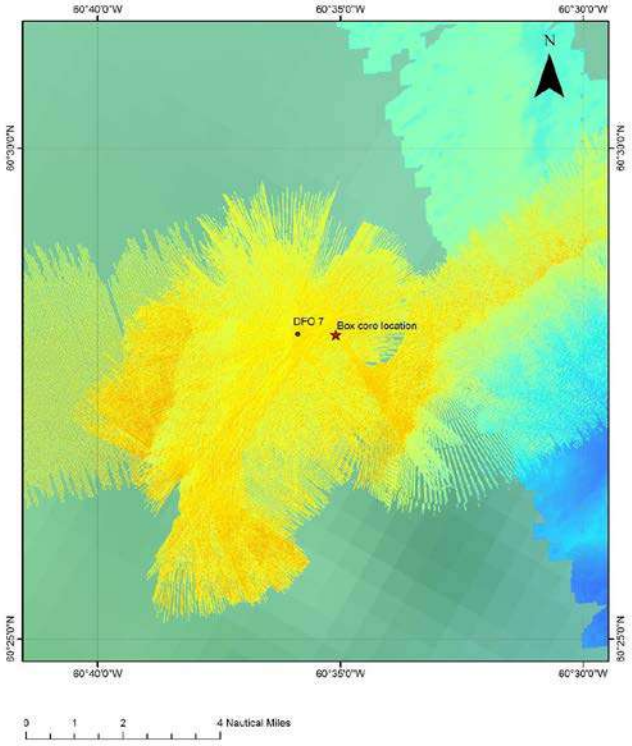

Figure 35-9 Sample Location on Seismic Profiles and Bathymetries (AMD1802c02BC)

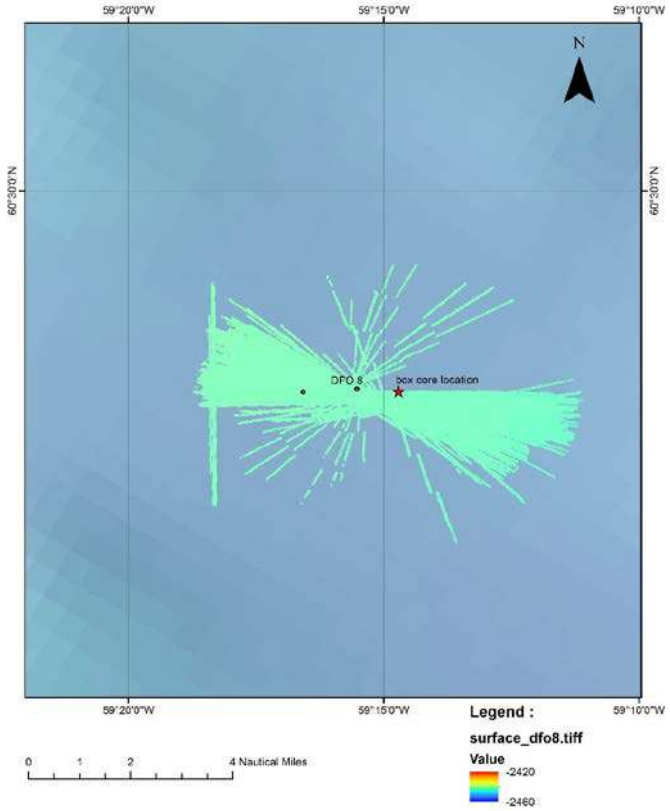

Figure 35-10 Sample Location on Seismic Profiles and Bathymetries (AMD1803c02BC)

35.4 Acknowledgement

We gratefully thank the chief scientist Philippe Archambault, the professor Evan Edinger, the Captain Claude Lafrance, the officers and crew of the CCGS *Amundsen* for their support, their help, and friendship throughout this leg of the 2018 ArcticNet cruise. We also acknowledge the support of Luca Arduini Plaisant for the mapping who greatly facilitated the site surveys.

36 Collecting Sedimentary Sequences for Paleoclimate, Paleoceanographic and Environmental Studies in the Eastern Canadian Arctic Archipelago and Baffin Bay – Leg 3

Project leader: Jean-Carlos Montero-Serrano[1] (jeancarlos_monteroserrano@uqar.ca)
Cruise participants – Leg 3: Jean-Carlos Montero-Serrano[1], Jade Brossard[1], Anne Corminboeuf[1] and Maria-Emilia Rodriguez-Cuicas[1]
[1] *Institut des sciences de la mer, Université du Québec à Rimouski, Rimouski, QC, Canada*

36.1 Introduction

The sampling undertaken during this expedition is framed within the IRIS 1 targeted research from the ArcticNet Phase 4 funded project Mapping of Arctic Canada's Seafloor: Contributions to Global Change Science, Sustainable Resource Development, Safe Navigation of the Northwest Passage, Geohazards and Arctic Sovereignty (project leader: Patrick Lajeunesse).

Benefitting from the presence of the of the CCGS *Amundsen* in Peel Sound, Queen Maud Gulf, Manson Glacier, Smith Sound, Trinity glacier, and Qikiqtarjuaq, the main objective of our team was the collection of multiple sediment cores (box, gravity and piston) in these areas in order to:

1. characterize the spatial distribution patterns of siliciclastic grain size, bulk minerals, and elemental geochemistry of seafloor sediments from the continental shelf and inter-island channels of the Canadian Arctic;
2. increase our understanding of deglacial dynamics in the Canadian Arctic;
3. to document the post-glacial melting history of the outlet glaciers draining the Mason glacier and Penny Ice Cap;
4. reconstruct changes in sediment provenance and transport related to climate variability;
5. establish a deglacial/Holocene high-resolution magnetostratigraphy for the Canadian Arctic Ocean;
6. document the evolution of primary and secondary productivity of the Canadian arctic ecosystem in relation with climate conditions;
7. identify and document the dinoflagellate communities living in Canadian Arctic:
8. provide new insights into potential relations between climate, ice-rafting, sea-level and oceanic circulation variations and sediment dynamics since the last deglaciation.

36.2 Methodology

The ISMER-UQAR team was responsible, together with Cindy Grant from Université Laval, for box coring operations. The piston corer was deployed by ISMER-UQAR team. The multibeam echosounder (Konsberg Simrad EM300) and 3.5-kHz chirp sub-bottom profiler (Knudsen 320R) were used, in collaboration with the Amundsen Science tech (Gabriel Joyal and Dominique St-Hillaire-Gravel), to ensure that the seabed was suitable for deployment of the corers, as well as to identify the thickest apparent deglacial/Holocene sequences with the absence of mass movements and/or sediment perturbations. Note that Gabriel and Dominique were responsible for mapping the seabed morphology and in acquiring sub-bottom stratigraphy during this leg.

36.2.1 *River Sampling*

The main purpose of the river sampling was to recovered riverbank sediments and rock fragments deposited near the mouth of rivers. Samples were recovered into two Ziploc bags and stored in a refrigerated container (4°C). A total of six rivers across northern Canada and the Canadian Arctic Archipelago (CAA) were sampled (Figure 43.1, Figure 43.2 and Table 43.1). These rivers drain watershed characterized by different geological provinces. We will analyse the mineralogical, geochemical and magnetic proprieties of these rivers samples. Each river has a different bed load and grain size, so the analyses will provide information to compare the rivers and to find the detrital sources of the sediments

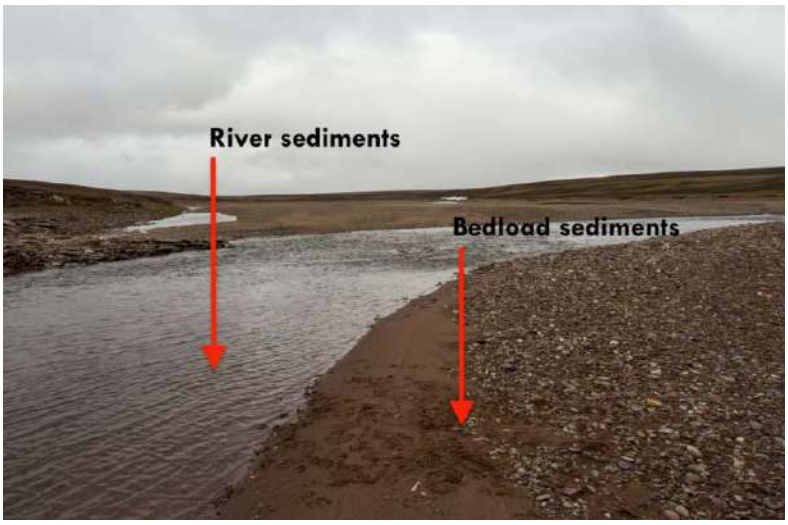

Figure 36-1 Example of sampling at a river site

Figure 36-2 Sampling bedload sediments

Table 43-1 Rivers sampling operations: location, identification and characteristics

River	*Latitude*	*Longitude*	*Comments for sediments*
River in Le Feuvre Inlet, Prince of Wales Isl.	72.473	-96.030	Gray clay
Simpson River	67.577	-100.099	Red clay
Ellice River	67.581	-104.545	Beige sand
Tingmeak river	68.103	-104.178	Grey clay
Garnier river	73.658	-92.912	Sand and gray clay
Cunningham river	74.240	-93.730	Sand

36.2.2 *Glacier Sampling*

To determine sediment provenance, we collected glacial sediment samples from an unknown glacier on the Devon Island and on the Manson Icefield (Figure 43.3 and Table 43.2). These glaciers contain the conflated mineralogical, geochemical and magnetic properties of sediment eroded from bedrock. Sediments and rock fragments samples were placed into Ziploc bags. Thus, these samples will be useful to give additional information about mineralogy, geochemistry, physical and magnetic proprieties of the glaciers.

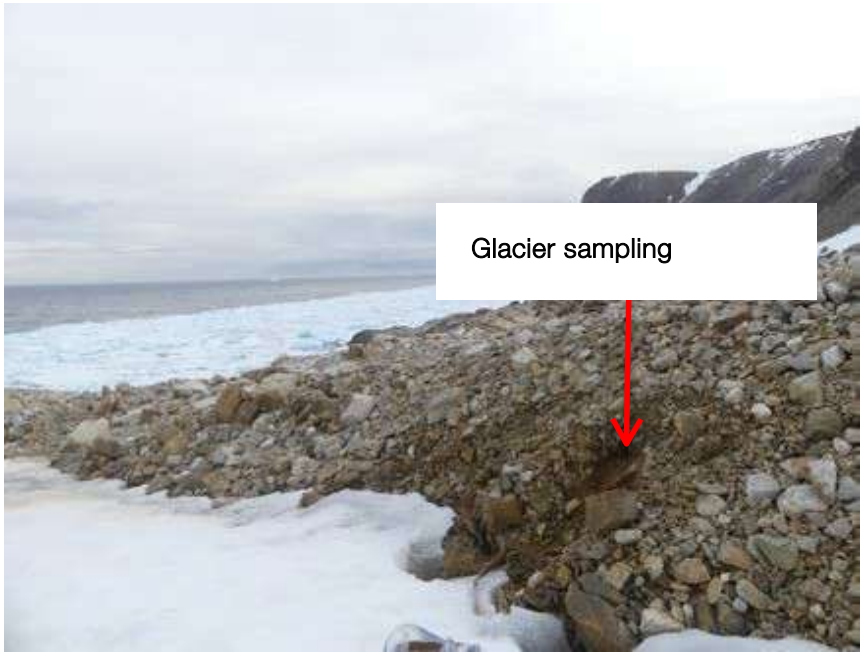

Figure 36-3 Glacier sampling example

Figure 36-4 Aerial view of a glacier near the Devon Island

Table 43-2 Glaciers sampling operations: location, identification and characteristics

Glacier	*Latitude*	*Longitude*	*ISMER-UQAR identifier AMD0318-*
glacier 1 (Devon island)	75.640	-80.711	Glacier 1
glacier 2 (Manson icefield)	77.976	-80.125	Manson glacier

36.2.3 *Box Corer*

The box corer (Figure 43.5) collects up to 0.125 m3 of soft sediments at the seafloor and is suitable for any water depths (limited by winch cable length). It is used for minimum disturbance of the sediment/water interface. During the expedition, the box corer was deployed 5 times (Table 43.3). When the sediment volume was sufficient (which was the case for all deployments), two push cores (PVC tubes of 10 cm diameter and ~60 cm length) were taken from each box (Figure 43.6) core using a vacuum pump to reduce compaction. The sediment/water interface from each box-core location was subsampled into several Ziploc bags for subsequent identification of microfossil (dinoflagellate cysts, non-pollen palynomorphs, benthic and planktonic foraminifera) as well as grain size, mineralogical, geochemical, and magnetic analyses. Each push core and surface sediment sample was stored in a refrigerated container (4°C).

Figure 36-5 Recovery of full box core (Penny Glacier station)

Figure 36-6 Push cores in open box core, prior to extraction (QMGM station)

Table 43-3 Box coring operations: location, depth, identification, and characteristics. Core site are shown graphically in Figs. 8. PC = Piston Core; TWC = Trigger Weight Core; GC = Gravity Core; BC = Box Core (including sequentially lettered push cores from the box core); surface = surface samples from box core only.

Station	*Date*	*Time UTC*	*Latitude*	*Longitude*	*Location*	*Water Depth (m)*	*ISMER-UQAR identifier AMD0318-*	*Push cores length (cm)*	
	(d/m/y)	*(24hr)*						*A*	*B*
Stn. QMGM	22/08/2018	16:59	68.29975	-101.74128	Queen Maud's Gulf	112	01BC	46	42.5
Stn. 1.1	27/08/2018	18:36	76.48059	-78.74047	Manson Glacier	124	02BC	27	29
Stn. 101	28/08/2018	02:59	76.38251	-77.40990	Smith Sound	373	03BC	29	29
Stn. 115	29/08/2018	07:50	76.33157	-71.17621	North-West Greenland	662	04BC	23.5	23
Stn 1.5	31/08/2018	18:54	67.28412	-63.91034	Qikiqtarjuaq (Penny Glacier)	609	05BC	43	43

36.2.4 *Gravity and Piston Corer*

The gravity core (Figure 43.7) has a maximum recovery length of ~2.80 m (in a 3.05 m aluminum barrel) using a stainless-steel cutting head and penetrating the sediment under a 136 kg weight. A core catcher keeps the sediment in the corer when the latter is pulled upward. Winch speeds (lowering) ranged from 60 to 80 metres per minute depending on estimated substrate properties. During the expedition, the gravity core was deployed 2 times (Table 43.4). The gravity core is also used for the releasing of the piston corer, being referred to as the trigger weight core (TWC) and rigged with a shorter 2.15 m aluminum barrel (liner length = 1.90 m). During the expedition, the gravity core was used for both purposes. Gravity core deployment and recovery is markedly quicker than the combined piston and trigger-weight core (15-20 minutes versus ~90 minutes), thus the gravity core can be deployed when thick sea ice would have posed a risk to the piston corer (hanging over the side of the ship for considerable time during deployment and recovery) and where time constraints necessitated shortened coring operations.

The piston corer (Figure 43.6) operates with a weight of 2000 kg with three 3.05 m steel core barrels connected with steel coupling sleeves attached with set screws, and a steel cutting head. When the companion trigger-weight core touches the seafloor, it causes the rise of the piston core's trip arm and induces the piston corer to free fall. A core catcher helps keep the sediment in the corer when the latter is pulled upward. This coring instrument allows the collection of long cores up to a maximum of 9 m length due to the suction exerted by the piston in the core tube. The piston corer was deployed 2 times during the expedition, and thus a total of 2 piston cores and 2 trigger weight cores have been sampled (Table 43.5). Once on board, all gravity and piston cores were cut into 1.5 m long sections and stored into a cold room (4°C).

Note that box-cores collected in conjunction with a piston corer allow recovery of the undisturbed sediment-water interface, which is usually perturbed when the piston corer enters the sediments. Ideally, push cores from box-cores can be correlated visually, chronostratigraphically, or geochemically with piston, trigger, and gravity cores from the same site.

Figure 36-7 Recovery of a gravity corer (QMGM station)

Table 43-4 Gravity coring operations: location, depth, identification, and characteristics. Core site are shown graphically in Figs. 8. PC = Piston Core; TWC = Trigger Weight Core; GC = Gravity Core; BC = Box Core (including sequentially lettered push cores from the box core); surface = surface samples from box core only.

Station	Date	Time UTC	Latitude	Longitude	Location	Water depth (m)	ISMER - UQAR-	Length (cm)	Section length (cm)		Comments
	(d/m/y)	(24hr)							AB	BC	
Stn. QMGM	22/08/2018	17:49	68.30330	-101.74270	Queen Maud's Gulf	114	01GC	285.5	149	136.5	overpenetration 1 sediments bag
Stn. Sunneshine Fjord	03/09/2018	12:33	66.60588	-61.72495	Sunneshine Fjord	165	02GC	164	147	17	

Figure 36-8 Piston corer on the fore-deck of the CCGS *Amundsen* awaiting connection and deployment

Table 43-5 Piston coring operations: location, depth, identification, and characteristics. Core site are shown graphically in Figs. 8. PC = Piston Core; TWC = Trigger Weight Core; GC = Gravity Core; BC = Box Core (including sequentially lettered push cores from the box core); surface = surface samples from box core only.

Station	Date	Time	Latitude	Longitude	Location	Depth (m)	identifier AMD0318	Length	Section length (cm)				
	(d/m/y)	(24hr)						(cm)	A B	BC	CD	DE	EF
Stn. 1.1	27/08/2018	19:36	76.48132	-78.73058	Manson Glacier	119	01PC	203.5	150	53.5	-	-	-
Stn. 1.1	27/08/2018	19:36	76.48132	-78.73058	Manson Glacier	119	01TWC	18.5	18.5	-	-	-	-
Stn. 1.5	31/08-2018	19:56	67.28464	-63.90958	Qikiqtarjuaq (Penny	609	02PC	222	150	72	-	-	-
Stn. 1.5	31/08-2018	19:56	67.28464	-63.90958	Qikiqtarjuaq (Penny	609	02TWC	68	68	-	-	-	-

36.2.5 *Core Identification and Labelling*

The sediment core samples were labelled using the following numbering system:

AMD0318-01BC
AMD = Amundsen
03 = Leg # 3
18 = Year 2018
01 = Station # 1
BC = Corer type (e.g., PC= piston core, BC = box core, GC= gravity core)
AB = Core section if applicable

Piston, trigger, and gravity core 1.5 m subsections are labelled as per Figure 43.9 with A being the base and section AB being the lowest section, followed by BC, CD etc. sequentially. Where multiple push cores were taken from a box core, they were labelled by the addition of a sequential alphabetical identifier, e.g. 03BC-A, 03BC-B, 03BC-C, etc.

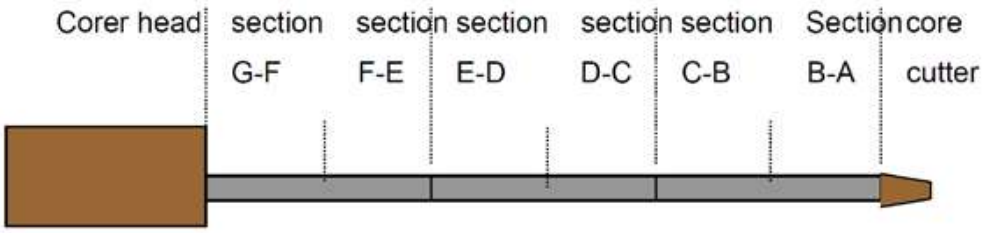

Figure 36-9 Labelling system for sections of piston and gravity cores

Core samples will be retained in refrigerated storage on the CCGS *Amundsen* during Leg 3 to be removed on demobilisation during early September in Québec City. Cores will then be shipped, stored, and analysed in detail at Rimouski.

36.2.6 *Sample Location on Seismic Profiles*

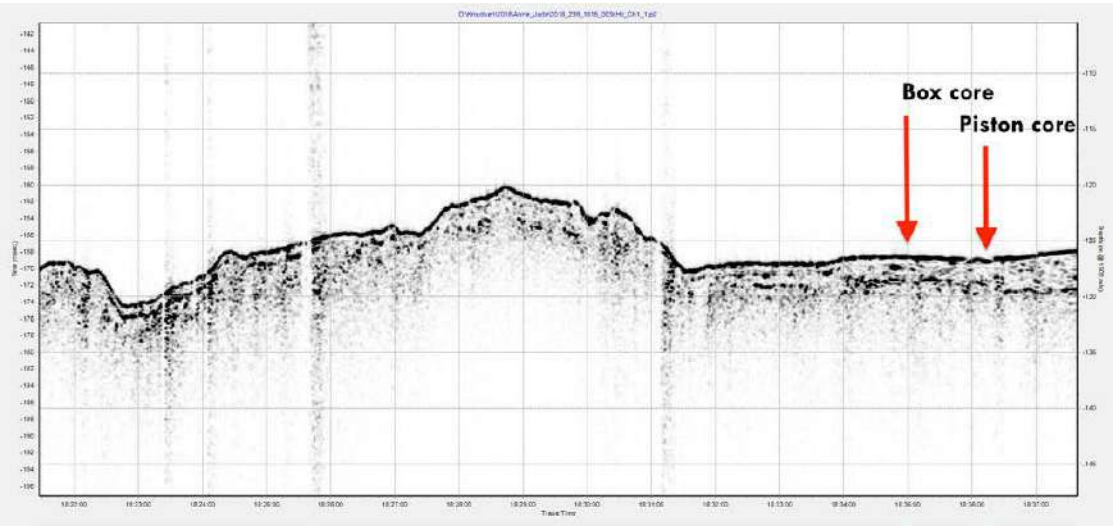

Figure 36-10 Station 1.1 *No seismic profile for the exact time of the piston core (due to derivation)

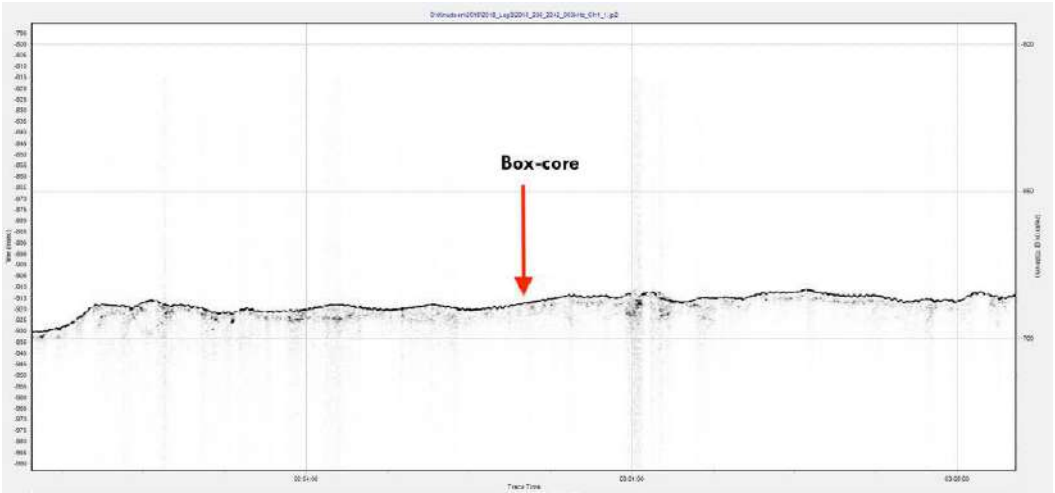

Figure 36-11 Station 101

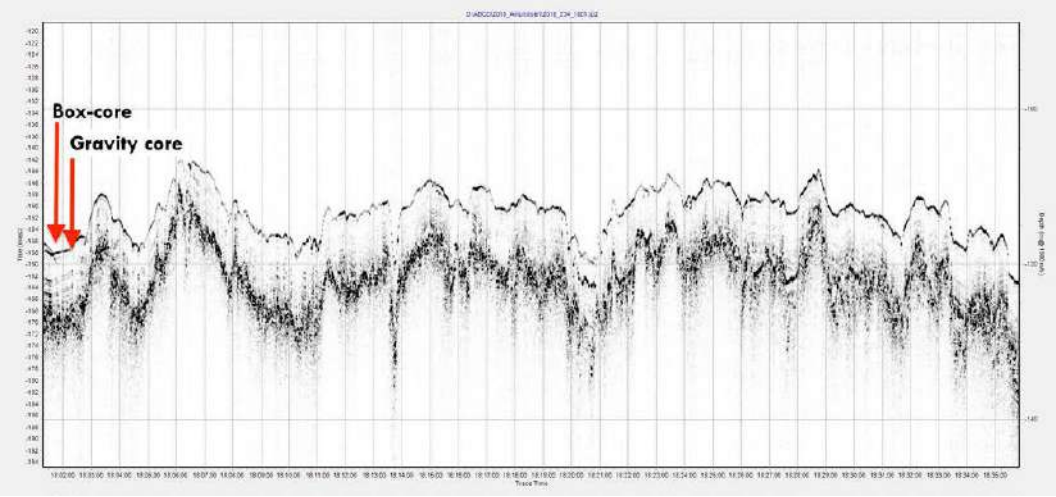

Figure 36-12 Station QMG-M

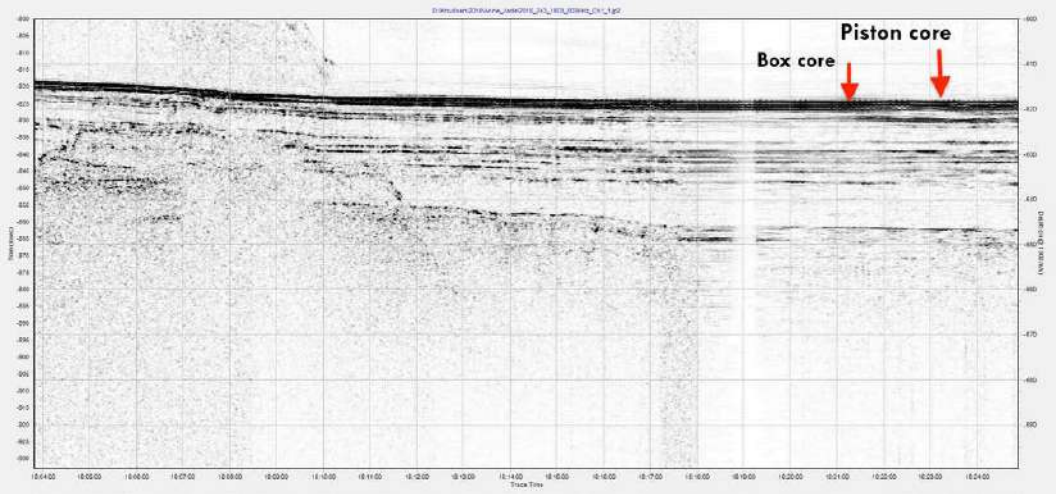

Figure 36-13 Station 1.5 *No seismic profile for the exact time (due to derivation)

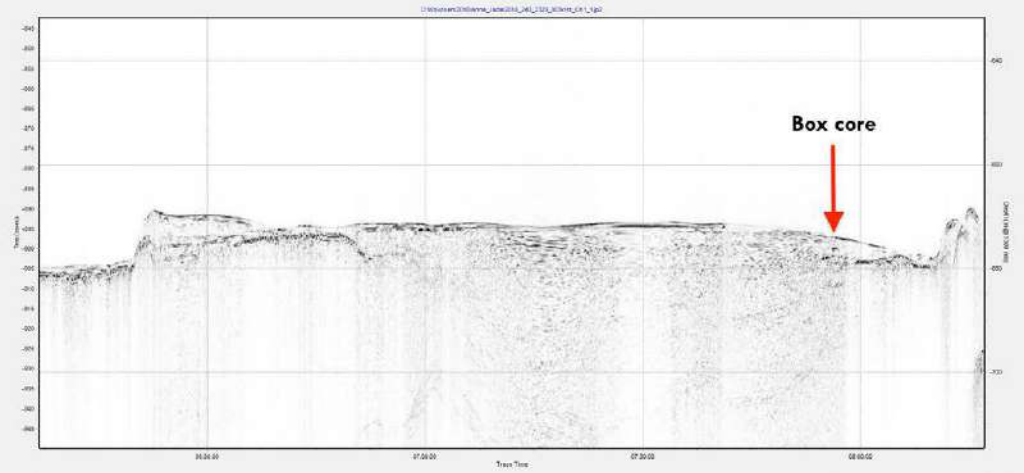

Figure 36-14 Station 115

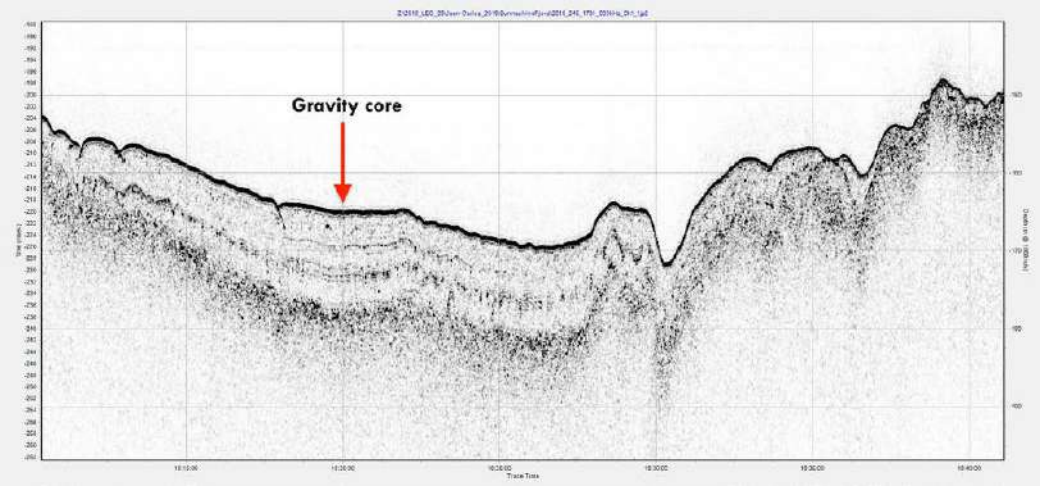

Figure 36-15 Station Sunneshine Fjord *No seismic profile for the exact time (due to derivation)

36.3 Preliminary results

Considering the challenge to work in the Arctic Ocean due to rough sea ice extent (particularly Peel Sound and Manson glacier), the mission was still successful with the collection of multiple sediments samples, considerably expanding sediment core coverage through the eastern Canadian Arctic and Northwest Passage. Sample location on seismic profiles and pictures are presented in Appendix B. A total of 5 box cores, 2 gravity, 2 piston cores, 6 rivers samples, and 2 glacier sediment samples were recovered at different locations along the Queen Maud Gulf, Lancaster Sound, Smith Sound, Manson Glacier, Trinity glacier, Qikiqtarjuaq (Penny Ice Cap) and Sunneshine Fjord.

All of these sediment samples will be analyzed in detail in the laboratory at Rimouski to achieve the objectives of this mission. Briefly, sediment samples will be studied for their mineralogical (bulk and clay fraction), geochemical (elemental and isotopic), microfossil (benthic and planktonic foraminifera), palynological (dinoflagellate cysts), magnetic, and siliciclastic grain-size signatures.

Such studies will provide a baseline to better interpret, in terms of sediment dynamics and climate change, the sedimentological signatures preserved in the Canadian Arctic sedimentary records, which may then help to place current eastern Arctic climate change.

Preliminary results are limited to direct observations of core penetration and sediments visible through the clear core-liner walls and exposed in box cores and in core cutters/catchers. In the Smith Sound, Manson Glacier, North-West Greenland, Qikiqtarjuaq (Penny Glacier) and Sunneshine Fjord, most of the surficial seabed sediments are predominantly composed of olive-grey silty clay. In contrast sediments from the Queen Maud Gulf areas consist of a relatively layer (~10 cm) of reddish brown silty clay (oxic layer) overlying a thin layer (2 cm) of black clay rich in organic matter (anoxic layer).

The time period covered by each core record depends on the sediment accumulation rate at each location. For longer records, this is expected to be highly variable as depositional processes change from the Late Pleistocene through the Holocene (high sedimentation rate ice-proximal glacimarine environments through to low sedimentation Late Holocene Arctic marine settings). The chronology of sedimentary sequences will be mainly determined by following the paleomagnetic approach proposed by Barletta et al. (2008, 2010) and Lisé-Pronovost et al. (2009). This chronostratigraphic analysis will be performed in close collaboration with ArcticNet Network Investigator Guillaume St-Onge. This paleomagnetic age model will be improved by a combination of AMS 14C ages on mollusc shells and/or foraminiferal (ideally monospecific planktic and benthic, when present) and 210Pb measurements on the companion box-cores.

Finally, from a student and HQP-training perspective, the expedition was a unique opportunity for Jade Brossard (Master student at ISMER-UQAR), Anne Corminboeuf (Master student at ISMER-UQAR), and Maria-Emilia Rodriguez-Cuicas (PhD student at UCV and ISMER-UQAR) to receive hands-on training in Arctic ship-based coring and sampling operations.

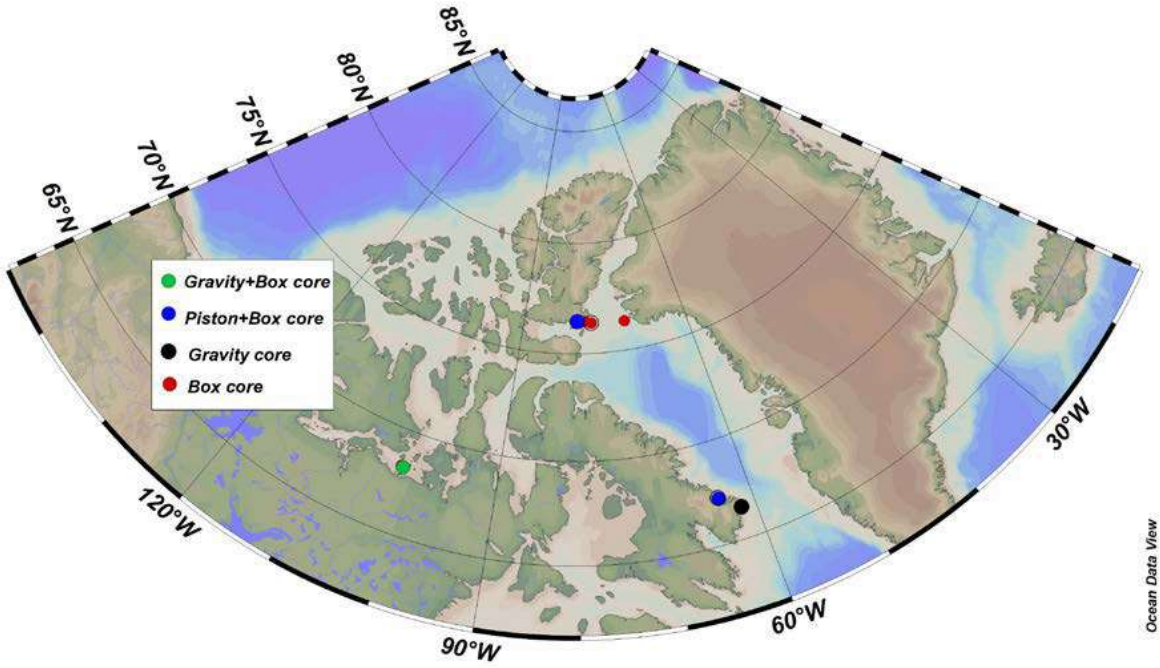

Figure 36-16 Sample location for the coring during the Leg 3 in the Amundsen expedition (2018).

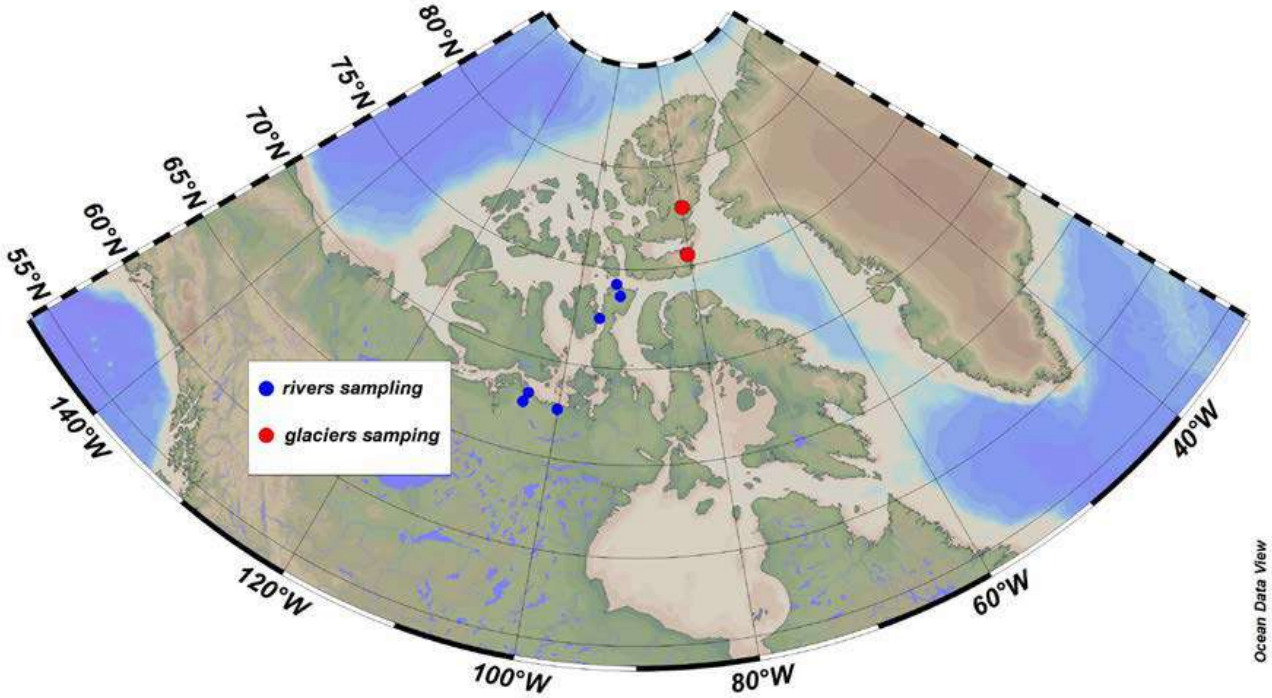

Figure 36-17Sample location of glaciers and rivers on the Leg 3 in the Amundsen expedition (2018).

36.4 Acknowledgment

We gratefully thank the chief scientist Alexandre Forest, the Captain Claude Lafrance, the officers and crew of the CCGS *Amundsen* for their support, their help, and friendship throughout this leg of the 2018 ArcticNet cruise. We also acknowledge the support of the mapping group (Gabriel Joyal and Dominique St-Hillaire-Gravel) who greatly facilitated the site surveys. Finally, we gratefully thank Abigail Dalton, Claire Bernard-Grand'Maison, Cara Manning, Robert Izett and Guillaume Carpentier for the river and glacier samplings.

37 Hidden Biodiversity and Vulnerability of Hard-Bottom and Surrounding Environments in the Canadian Arctic – Leg 2c

Project leaders: Philippe Archambault[1] (philippe.archambault@bio.ulaval.ca) and Evan Edinger[2]
Cruise participants – Leg 2c: Philippe Archambault[1], Alec Aitken[3], David Côté[4], Vonda Wareham Hayes[4], Evan Edinger[2], Bodil Lauridsen[5], Andrew Murphy[4], Anirban Chakreborty[6], Julek Chawarski[2], Shaomin Chen[7], Barbarà de Moura Neves[4], Gustavo Guarin[1], Aprami Jaggi[6], Katarsyna Polcwiartek[8], Karl Purcell[9], Catie Young[2], Vincent Auger[10], Peter Lockhart[10], Barry Brake[10], Kandice Piccott[11], Meghan Dicker[12], Holly Hogan[13], Sabina Blackbird[14] and Graham Tulloch[14]
[1] *Université Laval, Québec, QC, Canada*
[2] *Memorial University of Newfoundland, St. John's, NL, Canada*
[3] *University of Saskatchewan, Saskatoon, SK, Canada*
[4] *Department of Fisheries and Oceans Canada, St. John's, NL, Canada*
[5] *Geological Survey of Denmark and Greenland, København, Danemark*
[6] *University of Calgary, Calgary, AB, Canada*
[7] *Dalhousie Univeristy, Halifax, NS, Canada*
[8] *University of Manitoba,Winnipeg, MB, Canada*
[9] *Université du Québec à Montréal, Montréal, QC, Canada*
[10] *Canadian Scientific Submersible Facility, North Saanich, BC, Canada*
[11] *Amundsen Science, Université Laval, Québec, QC, Canada*
[12] *Nunatsiavut Government, Nain, NL, Canada*
[13] *Environment and Climate Change Canada*
[14] *Atlas consortium, Liverpool, United-Kingdom*

37.1 Introduction

The ROV-based research program on hard-bottom and vulnerable benthic environments aboard the CCGS *Amundsen* during its 2018 mission is sponsored jointly by ArcticNet, an NSERC Ship-time (STAC) grant, the Amundsen Science program, Fisheries and Oceans Canada, and the ATLAS consortium, funded by the European Union Horizon 2020 program. The major goals of the ArcticNet HiBio (Hidden biodiversity and vulnerability of hard-bottom and surrounding environments in the Canadian Arctic) project are to discover previously unknown coral and sponge biodiversity, other invertebrate and fish biodiversity, and previously under-sampled habitat types in the Canadian Arctic, especially the Eastern Arctic including the northern Labrador Sea and Baffin Bay.

Particular emphasis is placed on steep and deep hard-bottom habitats that cannot be sampled effectively using traditional oceanographic sampling methods such as box-cores. The goals of the NSERC-STAC funded program were more focused on cold-water coral environments, especially their carbonate budgets, surficial geology, and carbonate taphonomy, their physical oceanography, especially near-bottom turbulence in gorgonian coral forests, and the paleoceanographic records that can be extracted from coral skeletons. The DFO-funded program Integrated Studies and Ecosystem Characterization of the Labrador Sea (ISE-COLD) aims to describe the biodiversity of the deep waters of the northern Labrador Sea, focusing on the continental slope between 500 and 2000 m, and the abyssal depths greater than 2000 m.

The EU-funded ATLAS program provided benthic landers that complement the oceanographic moorings deployed by the NSERC-funded research program. Together the landers and moorings describe near-bottom currents, particulate organic matter supply and composition, and marine mammal occurrences as recorded in a hydrophone.

The Super Mohawk (SuMo) ROV aboard CCGS *Amundsen* forms an integral part of the ArcticNet Hidden Biodiversity, NSERC STAC, and DFO funded programs. Associated research used instrumental data and water sampling from the CTD and rosette, invertebrate and ichthyoplankton sampling using the monster and Hydrobios nets, and benthic sampling using the box corer and Agassiz trawl to sample the same environments through the water column, while seafloor mapping with multibeam sonar and sub-bottom profiler characterizes the seafloor underlying these benthic environments. Our integrated geological, biological, and oceanographic sampling addresses these understudied environments in a holistic fashion.

Most sites were chosen based on previously identified coral and/or sponge diversity and abundance hotspots from scientific trawl survey or commercial fisheries bycatch data. These included the various sites around, NE Saglek Bank, Hatton Basin & SE Baffin Shelf Similarly, the bamboo coral forest at the Disko Fan (Neves et al., 2015) has been studied extensively in our 2013 and 2016 cruises, and an experiment was recovered from there during our 2017 cruise. Finally, an important scientific goal was to carry out detailed ROV investigations and sampling of the recently discovered Lophelia pertusa scleractinian coral occurrences in southwest Greenland (Kenchington et al., 2017).

This mission was an interdisciplinary effort to understand Vulnerable Marine Ecosystems (VME) of the northern Labrador Sea, on both the Canadian and Greenland sides, as well as in southern and western Baffin Bay. The mission included many inter-related components, using the SuMo ROV, a newly developed drop-video camera, water sampling using the CTD/rosette, plankton and fish sampling, box-coring and Agassiz trawling to study benthic fauna, marine habitat mapping using multibeam sonar and sub-bottom profiling, and gravity coring to study the accretion rates of the bamboo coral forest. The variety of activities are reflected in the broad range of objectives listed below. This report focuses on the results of the ROV dives, and summarizes the water sampling for dissolved nutrients, stable isotope analysis of dissolved nutrients, and carbonate chemistry. For detailed results of the other components of the research program in the VME's cruise leg, please see related cruise reports for the ArcticNet Frobisher Bay project (Aitken/Edinger), DFO (Cote/Murphy), GEUS (Lauridsen) the ATLAS consortium (Blackbird/Tulloch), University of Calgary (Hubert/Chakraborty), Dalhousie/UQAM (Chen/Sherwood; Purcell/Hillaire-Marcel), Mooring team (Meredyk/Fortier) and CWS (Hogan).

37.1.1 *General Scientific Ojbectives*

1. Assess biodiversity and depth distribution of corals, sponges, invertebrates and fish in deep-water areas of the northern Labrador Sea, including eDNA and pelagics.
2. Describe geomorphology of sites hosting the highest coral and sponge diversity, along the depth gradients.

3. Assess currents and seasonal variation in particulate organic matter composition in the largest coral and sponge hotspot of the NW Labrador Sea, at the northeastern edge of Saglek Bank.
4. Assess seabird and marine mammal fauna within the proposed deep-water Marine Protected Area (MPA) off northern Labrador.
5. Describe the depth distribution and biodiversity at the SW Greenland Lophelia pertusa scleractian coral locality, and the relationship to bottom geology and geomorphology.
6. Assess longevity and accretion rates of gorgonian and scleractinian coral habitats of the Labrador Sea and SE Baffin Bay.
7. Evaluate the strength of the West Greenland current over centennial to millennial timespans.
8. Measure calcium carbonate saturation state and stable isotopic composition of dissolved nitrate and particulate organic matter in coral and sponge hotspots, to compare with the stable isotopes in coral calcite and protein layers for assessing paleoceanographic records in both calcareous and proteinaceous deep-sea corals.
9. Analyze paleoceanographic records of primary production over centennial to millennial time-scales from gorgonian, antipatharian, and scleractinian coral skeletons.
10. Assess the microbiology and associated oceanography of natural hydrocarbon seeps in Arctic waters.
11. Characterize the composition of natural and anthropogenic hydrocarbons found in Arctic waters, particularly in Frobisher Bay and near with the natural hydrocarbon seep at Scott Inlet.

37.2 Methodology

A total of nine locations in the northern Labrador Sea and southeastern Baffin Bay were chosen to be surveyed using the SuMo ROV during the Amundsen 2016 expedition: NE Saglek Bank coral hotspot at several depths, the NE Hatton Basin outer sill site at two depths, SE Baffin antipatharian coral concentration north of the edge of the Hatton sill, the Lophelia pertusa scleractinian coral ecosystem along the continental slope of SW Greenland, and the persistent hydrocarbon seeps at Scott Inlet, Baffin Bay.

Furthermore, we targeted gravity coring in the bamboo coral forest at the Disko Fan site studied in 2016, in order to provide replicate measurements of the age of this biogenic habitat, and the rates of sediment accumulation in the coral patches versus the spaces between the coral patches.

At each station, the intended sampling methodology consisted of: multibeam sonar and 3.5 kHz sub-bottom profile survey, one or two ROV dives, water column profile sampling with CTD and rosette, plankton sampling using vertical tows, (monster or hydrobios nets), mesopelagic fish assessment using the IKMT trawl, and benthos characterization using box core and/or Agassiz trawl where the bottom was suitable for these samplers. The box core and Agassiz trawl were cancelled in locations that appeared to contain too many boulders, and might therefore risk damaging the trawl, or where the biogenic community was known to be highly sensitive to mechanical damage. Box-cores was stopped immediately in locations where the box corer

appeared to be suffering damage from rocks. In waters deeper than 1000 m, the DFO drop video was used. Furthermore, the drop-video camera was used to provide additional video data, or to replace video data in cases where the ROV dive failed or was extremely short.

The SuMo ROV has a high definition (HD) camera (1Cam Alpha, Sub C Imaging, 24.1 megapixels) and two green lasers 6 cm apart for size indication. We used the FH video recording mode (second best resolution), since using the best resolution would reduce the camera storage capacity.

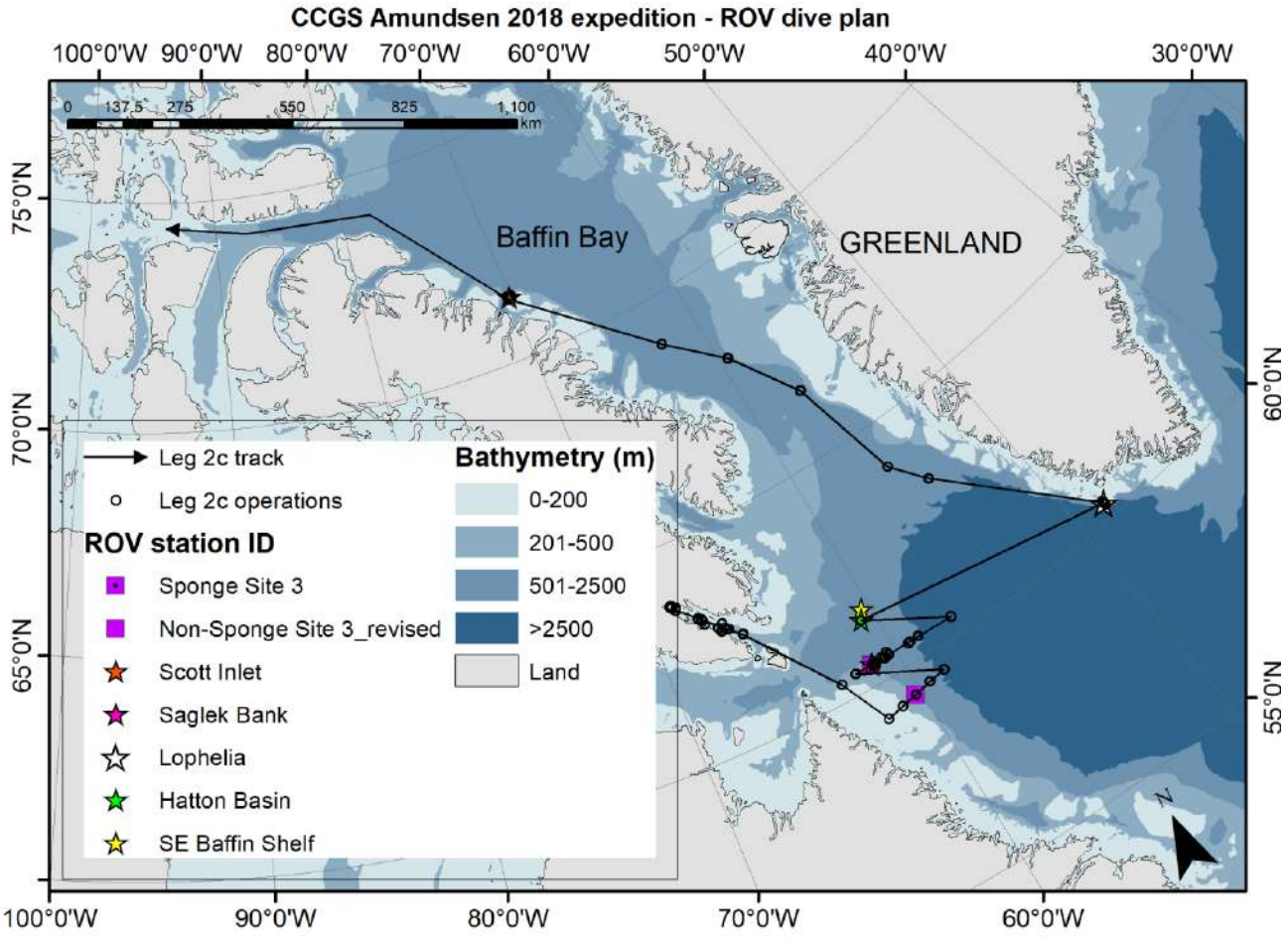

Figure 37-1 Cruise track of the 2018 CCGS *Amundsen* expedition, Leg 2c. Start in Iqaluit, end in Resolute

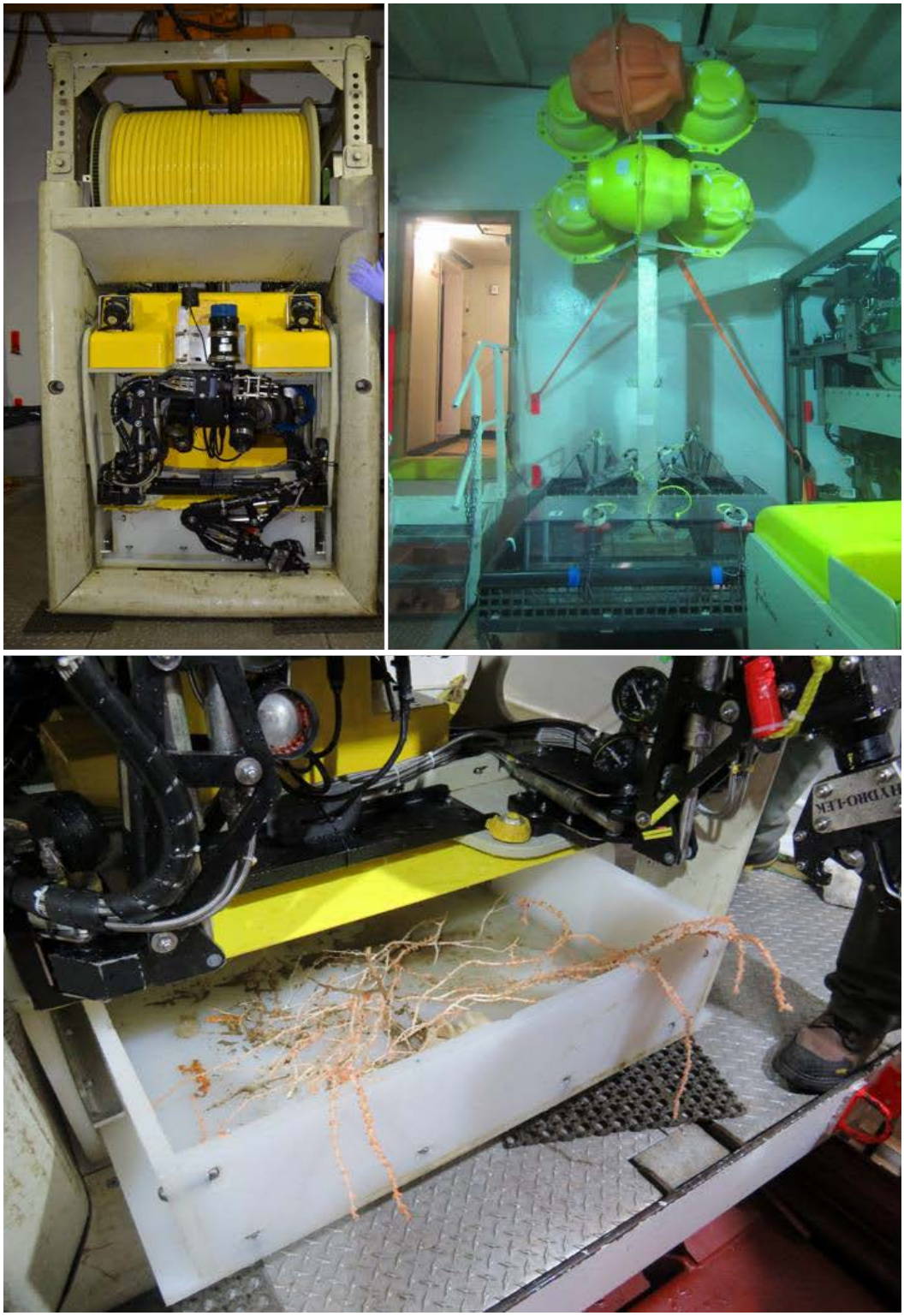

Figure 37-2 A) Super Mohawk (SuMo) ROV, B) elevator, and C) sampling skid with samples of the bamboo coral Keratoisis sp. Photo from 2016 cruise.

37.3 Preliminary Results

Table 44-1 Summary of sites surveyed and sampled with the SuMo ROV and other tools during the 2018 CCGS *Amundsen* expedition, not including the Frobisher Bay sites. Numbers refer to the number of deployments of particularly sampling equipment in an area. Otherwise, X refers to extensive collection, while x refers to more limited collection.

Date	Site	Latitude (N)	Longitude (W)	Depth (m)	ROV Div	MBES	3.5 kHz	Drop camera	H_2O	Plankton	Pelagic fish	Box core	Agassiz trawl	Gravity core
25 July	Frobisher Bay	63.53742	-68.38105	88-441	-	X	X	3	x			X	1	
26-July	Frobisher Bay	63.08102	-67.42524	107-589	-	X	X	4	X			x	1	
27-July	Frobisher - steaming	-	-	-		X	x	1	x			x		
28-July	SE Saglek Bank	60.3807	-60.2805	550	A63	x	x	1	x	x	x	1	1	
29-July	NE Saglek Bank	60.4684	-61.2599	500	A64	X	X	2	x	x	x	-	-	
30-July	NE Saglek Deep	60.4692	-61.1056	1160		X	X	1	x	x	x	1	-	
31-July	NE Saglek Deep	60.4665	-61.1642	1000	A65	X	x	1	x	x	x	3	1	
01-Aug	NE Saglek 750 m	60.4337	-61.1976	750	A66	x	x	1		x	x	1		
02-Aug	NW Labrador Sea	60.4736	-60.6064	1424	--	X	x	1	x	x	x	1	-	
03-Aug	NW Labrador Sea	60.4665	-60.3750	1920	--	x	x	1	x	x	X	2	1	
	NW Labrador Sea	60.4686	-59.2632	2440				1		X	x			
04-Aug	NW Labrador Sea	60.4533	-57.0817	3000	--	x	x			x	X			

05-Aug	NE Hatton Sill	61.4396	-60.6634	620-550	A67	2006	X		x			-	-	
06-Aug	Steaming	-	-	-		X	X					-	-	
07-Aug	SW Grld. *Lophelia*	60.3664	-48.4572	950-700	A68	X	X		1	1		-	-	
08-Aug	SW Grld. *Lophelia*	60.3669	-48.4662	950-700	A69	X	X		1			x		
09-Aug	Steaming, water	63.2496	-54.2005	1175					2					
10-Aug	Disko Fan	67.9774	-59.4945	895		2013	201		1			1		5
11-Aug	Steaming, water	68.9765	-62.4831	1892					1					
12-Aug	Scott Inlet	71.3783	-70.0737	260	A70	2013	201		2					
13-Aug	Scott Inlet	71.4096	-69.97168	266	A72	2013	2013		9				1	

37.4 Operations

37.4.1 *ROV Dives*

Dive A63: SE Saglek Bank, 550 m. 28 July 2018 (Figure 36.3 to Figure 36.6)

This is the location of the ATLAS lander in the “non-sponge” site, at which near-bottom currents and downward particulate flux will be measured for the next 11-12 months, for comparison with similar lander measurements at the coral- and sponge-rich site at NE Saglek Bank. The location of this site was chosen as the area within the Hatton Basin fisheries closure with the lowest sponge bycatch value according to the Northern Shrimp Survey standardized trawl surveys, along the southern extension of this closure southward along the edge of Saglek Bank.

The initial “non-sponge” site, about 30 miles further south, was rejected due to the risk that the lander could be hit by fishing gear in an area that is open to fishing and that has been fished. There was also the possibility that the low sponge values recorded in the trawl surveys were partially a result of past fishing pressure.

The primary purpose of the ROV dive at this location was to verify that the location did not have large boulders, and that therefore it would be suitable for deployment of the ATLAS lander. Unfortunately, electrical problems with the ROV, problems with the tether cable winch inside the ROV cage, and frequent loss of video and telemetry made it difficult to retract the ROV into the cage. The video data of the site was collected with the ROV inside the cage, in drop-video camera mode. The ship and cage + ROV were allowed to drift over the bottom, at a controlled speed. The ROV drop-video survey showed that the bottom here is gravelly sand, with few boulders, and therefore suitable for deploying the lander.

Before the lander was actually deployed, another drop camera survey was carried out using the DFO drop video camera, drifting approximately 400 m over the bottom. This survey showed many small sponges, including Asconema sp., Polymastia spp., the white tulip sponge, an erect white sponge, and a variety of small encrusting sponges (Figure 36.5). Some small sponges could be seen (including what were probably some Geodia sp.).

The electrical and telemetry problems with the ROV made it unsafe to deploy the ROV for a second dive to verify the placement of the lander on the bottom. The scarcity of rocks on the bottom, however, suggests that the lander position should be suitable.

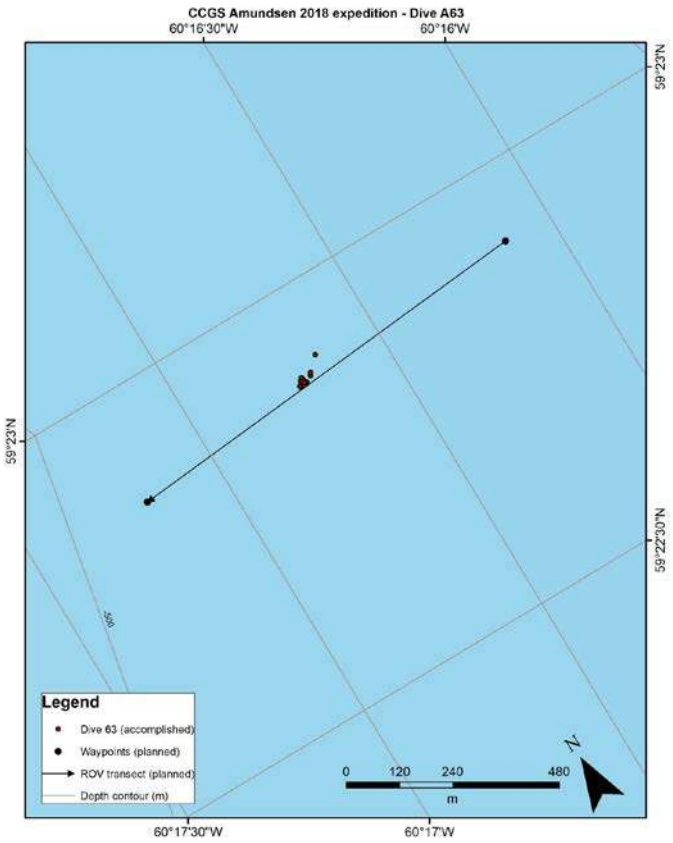

Figure 37-3 Map of SE Saglek Bank site (dive A63) also called “non-sponge site 3”, showing planned and accomplished ROV transects during Leg 2c of the 2018 CCGS *Amundsen* expedition.

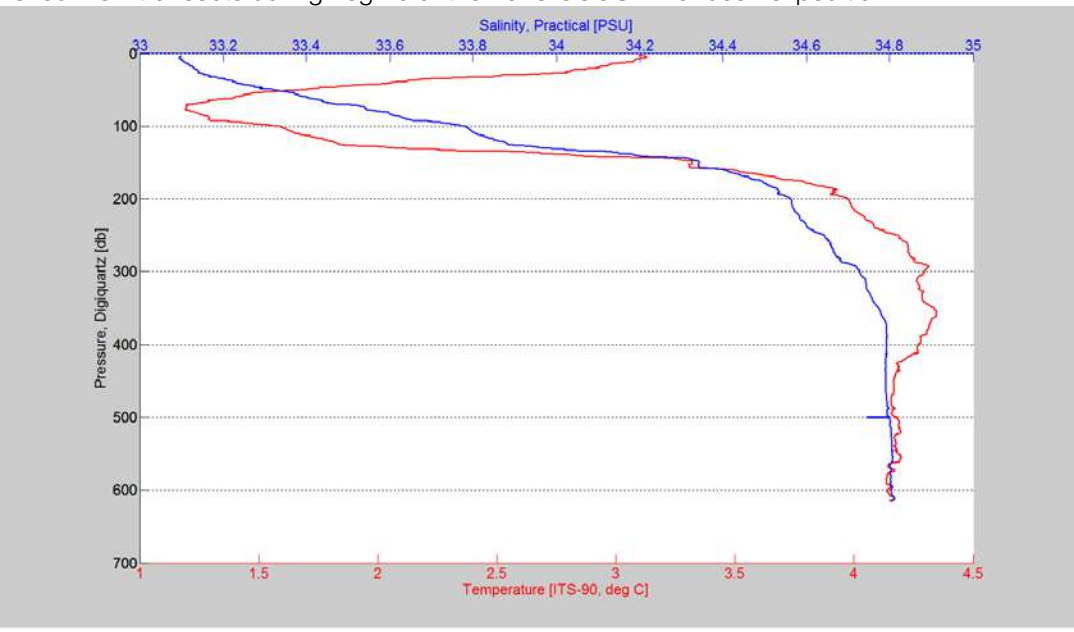

Figure 37-4 Temperature and salinity plot for SE Saglek Bank (non-sponge site 3, dive A63)

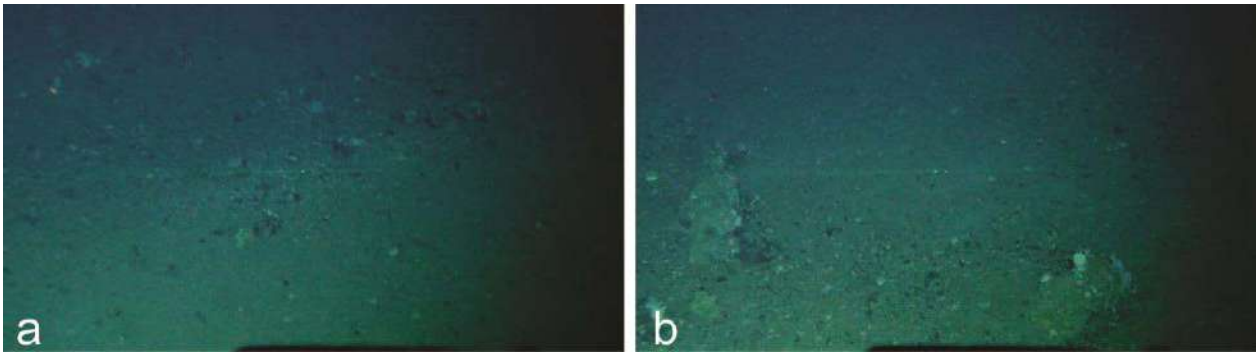

Figure 37-5 Photo-plate of bottom observed during the ROV investigation at SE Saglek Bank (non-sponge site 3, dive A63). Lasers are 6 cm apart

Figure 37-6 Photo-plate of bottom observed during the ROV investigation at SE Saglek Bank (non-sponge site 3, dive A63). Lasers are 6 cm apart.

Dive A64: NE Saglek Bank, 500 m (site of deployment of HiBio2017A mooring). 29 July 2018 (Figure 36.7 to Figure 36.9)

This dive has been squeezed in between a partial mooring recovery and an early end to daytime operations. The mooring could not be recovered prior to dive due to fog, and as a result the ROV launch target was shifted 300 m downwind from mooring at same depth zone (~ 500 m). Direction of dive video transect was into the wind (15-20 kt), but slightly downslope. Northern Shrimp trawl survey data for this location indicate low coral biomass dominated mostly by soft corals, very different from 450 m deep trawl only a few nautical miles away, which was the original target of the mooring. The main objectives of this dive were to survey coral and sponge fauna at

site where mooring was deployed, as well as to collect live Primnoa, dead Primnoa skeletons, sponges, and soft corals.

This site was surveyed with the SuMo camera, to verify the coral and sponge fauna found near the site of the HiBio2017A mooring which was deployed in October 2017. High seas during the deployment in 2016 caused the mooring to be off target by about 2 km, and about 50 m deeper than the intended depth. When the mooring was recovered, it was found to have moved about 200 m along the bottom between October 2017 and July 2018. The trawl survey bycatch value for this site is dramatically lower than that recorded at the site of the 2016 dive.

Unfortunately, the combination of strong currents and frequent loss of video through the damaged ROV umbilical cable meant that it was unsafe to bring the ROV out of its cage. This dive was accomplished with the ROV inside its cage, in “guided ROV drop-video camera” mode.

Maximum slope indicated on multibeam bathymetry in this location was 8 degrees, appearing to be a steady gradient downslope, with no dramatic topography. Bottom currents were strong in this location (offset between ship and cage ~ 1 ship length), so we used ROV drop-video camera mode. Visibility was poor. Amphipods were abundant in the water column, which were collected with the sampling skid. Because video loss was too frequent, the dive was aborted after ~75 minutes on bottom.

The bottom type was sandy gravel with cobbles and large boulders. The site surveyed was sloping gently toward the open Labrador Sea. This site lies shallower than the top of the rill-and-gully zone, the topography on the site was quite gentle, with very little difference in depth recorded along the transect.

Bottom type was mainly sandy gravelly bottom. Small sponges and soft corals (Family Nephtheidae) were abundant at this site (probably Geodia spp.). Other sponges include Asconema sp., Polymastia spp., Axinella sp., and two unidentified encrusting sponges, a yellow sponge possible the epibiont Hexadella dedritifera, and a blue sponge possible Hymedesmia (Hymedesmia) paupertas (see Dinn and Leys, 2018). Other corals observed include red mushroom corals (Family Alcyoniidae, likely Anthomastus sp.), Primnoa resedaeformis (live and dead – skeletons). Primnoa resedaeformis colonies were mostly small, and abundant at certain parts of the dive. Large colonies were rare, very few are >1m tall. Sea anemones (unidentified) were also common at this location. Fish diversity was low, with only Redfish (Sebastes spp.) observed.

Figure 37-7 Map of NE Saglek Bank, 500 m (dive A64) showing planned and accomplished ROV transect during Leg 2c of the 2018 CCGS *Amundsen* expedition. Accomplished waypoints indicate points where the bottom was visible, with no camera loss.

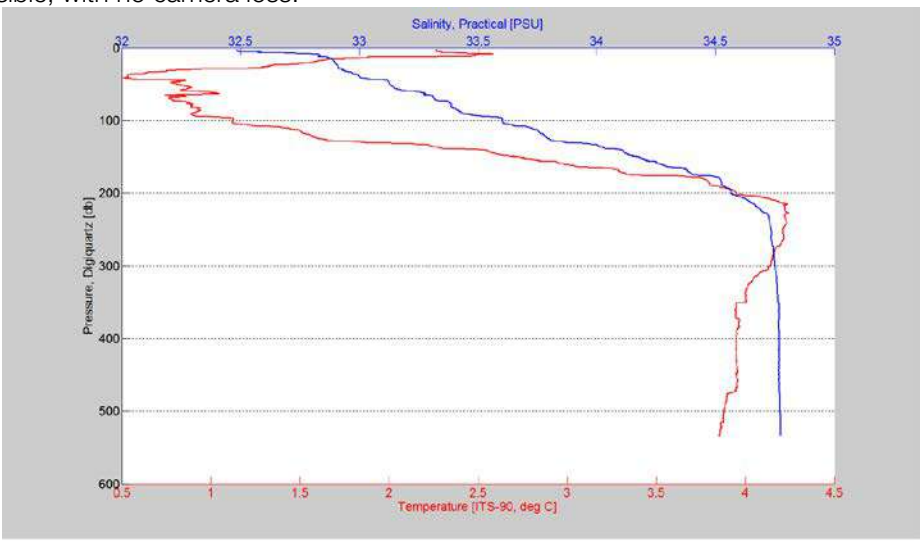

Figure 37-8 Temperature and salinity plot for NE Saglek Bank site (500 m), site where the HiBio2017A mooring was deployed, and which was surveyed in 2018 during the ROV dive A64.

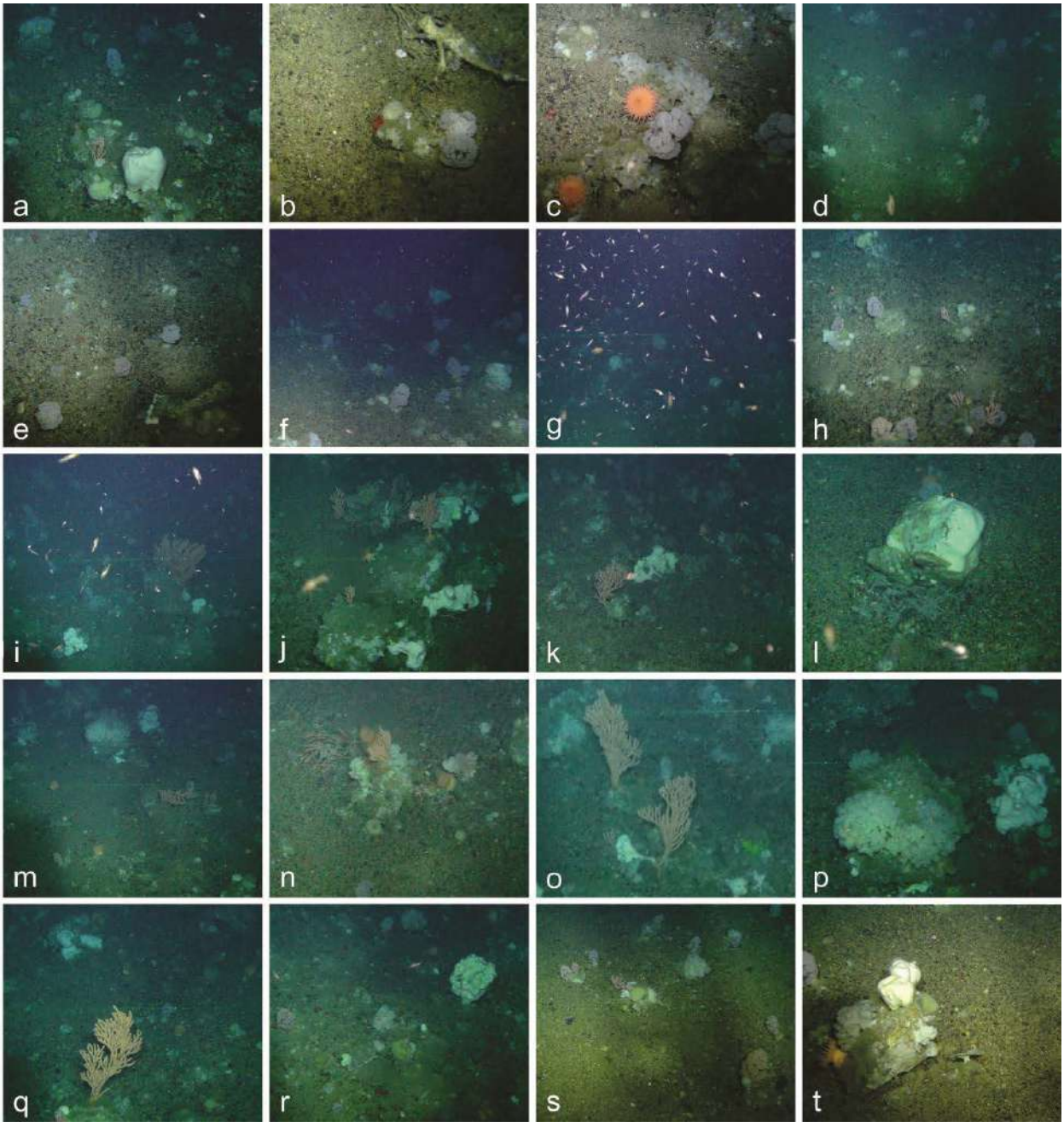

Figure 37-9 Photo-plate of megafauna observed during the ROV video transect of dive A64.
a. corals and sponges with large *Geodia barretti* in foreground; b. sponges and soft corals with dead *Primnoa*; c. soft corals with sea anemones and glass sponge *Asconema*; d. soft corals; e. soft corals with dead gorgonian (bottom right); f. soft corals; g. water productivity. h. soft corals and small *Primnoa* colonies; i. soft corals and a large *Primnoa resedaeformis;* j-l. Small *Primnoa resedaeformis* on boulders with large overturned *Geodia* sponges; m-o. Overturned *Primnoa* with sponges. p. *Asconema* and *Geodia* sponges; q. *Primnoa resedaeformis* and *Geodia* sponges; r-t. Sponges (large Geodia barretti, *Polymastia* spp., *Asconema* sp, and other species) and soft corals.

Site DFO 2, 750 m and 1000 m

This site surveys the coral, sponge, benthos, plankton and fish faunas at the shelf break next to the NE edge of Saglek Bank, in the 700 to 1000 m depth range. The shelf break is quite steep, with average slopes about 10 degrees. Multibeam bathymetry showed that the GEBCO bathymetry here was inaccurate, as indicated in the dive plan: the location identified as the 750 m contour in the GEBCO database was 1000 m deep, and the location identified as the 1000 m contour was actually about 1150 m deep.

Accordingly, the DFO drop video camera was used to survey the fauna in the valley at 1150 and 750 m, and along the ridge at 1000 m. The ROV was used in drop camera mode to survey the fauna and bottom types along the top of the ridge at 750 m (dive A66). The ridge was the top of a rill in the rill-and-gully zone. The ridge had quite low relief in the 700-750 m depth range, but was considerably more elevated above the surrounding seafloor in the 1000 m depth range (Figure 36.10).

Dive A65: 1000 m dive off NE Saglek Bank. 30 July 2018 (Figure 36.10 and Figure 36.11).

The main objectives of this dive were to survey epifauna at 1000 m off of the bank and to collect corals, sponges, and other large epifauna from this depth zone. The 1000 m contour is in the position identified as 750 m deep in the GEBCO database. This dive was aborted due to twisting of cable wire and tension which caused video to fail repeatedly. Dive ended at 982 m.

After dive A65 the CSSF team proceeded with a re-termination of the umbilical cable - 300 m of the cable were cut before the subsequent dives.

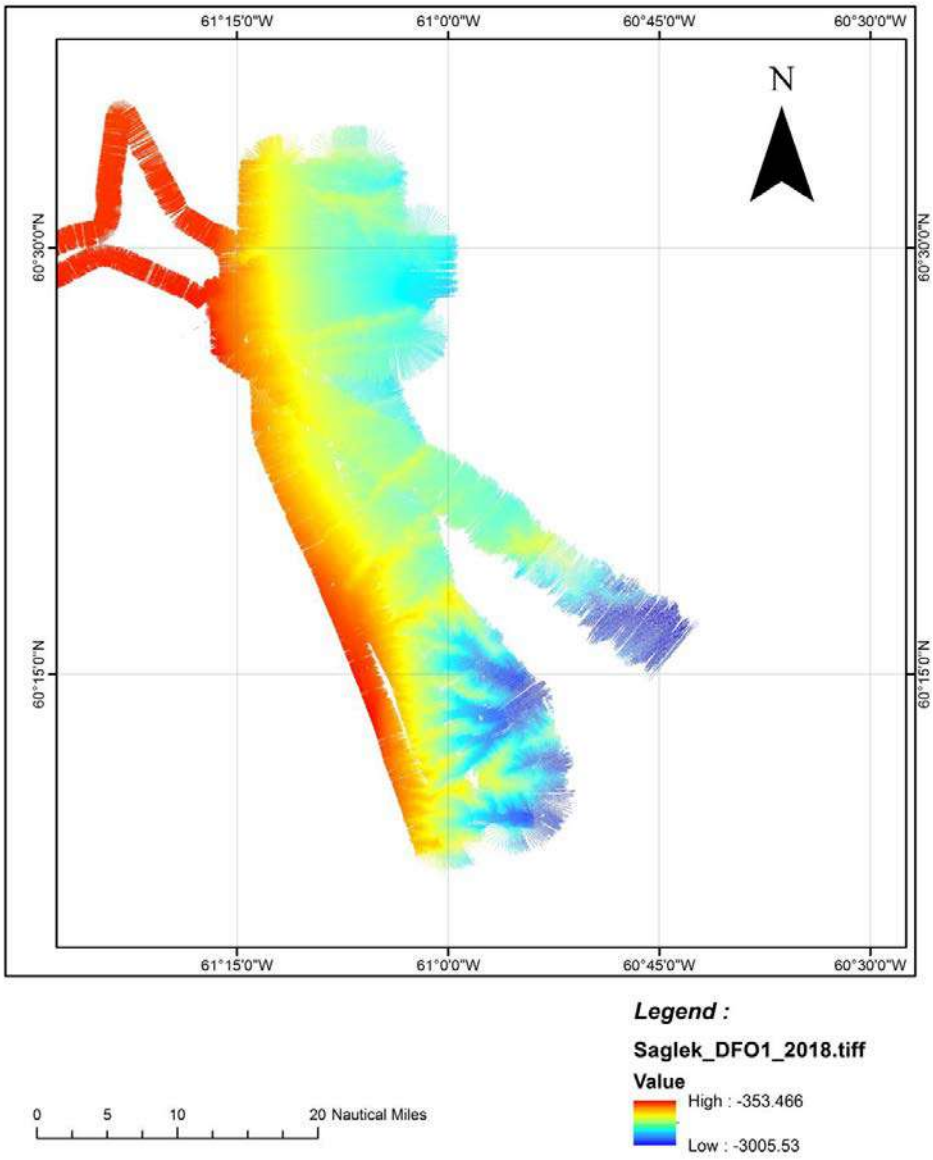

Figure 37-10 Map of new multibeam bathymetry collected at the NE Saglek Bank shelf break and upper slope. The northern portion of the map area (N of 60 16'N) shows rill-and-gully morphology, consistent with the canyon morphology along the full latitudinal extent of the Hatton Basin sill. South of 60 16'N is the northern-most occurrence of a more typical dendritic submarine canyon morphology along the shelf break and upper slope of NE Saglek Bank. Corals and sponges appear to be most abundant in waters shallower than 500 m, on the shelf break above the rill-and-gully zone. DFO drop video camera deployments were made at 1100 m (valley), 1000 m (ridge), 750 m (valley) and an ROV drop-video survey (A66) was carried out up the ridge at 750-700 m, which will be discussed next.

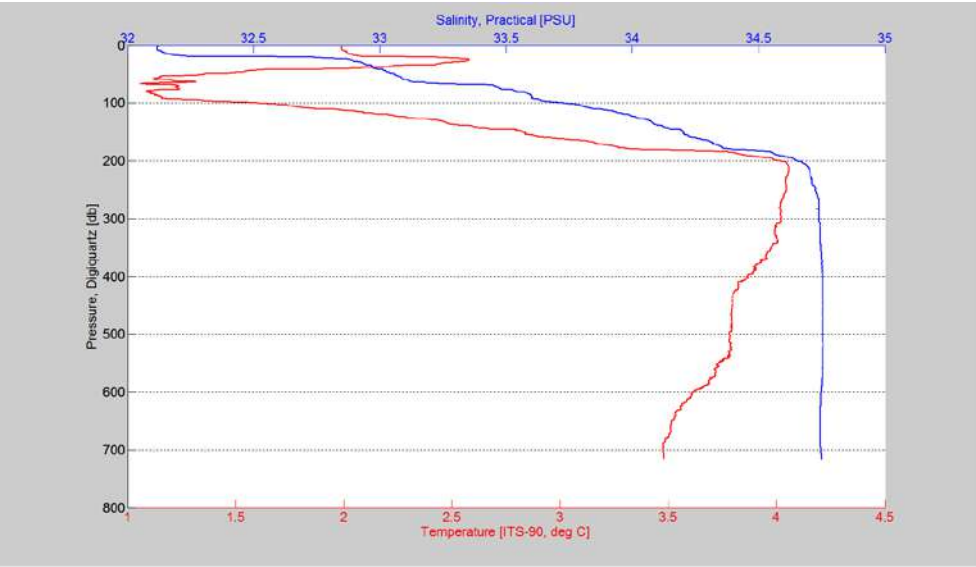

Figure 37-11 Temperature and salinity plot for rosette station DFO 750 m (Cast 31).

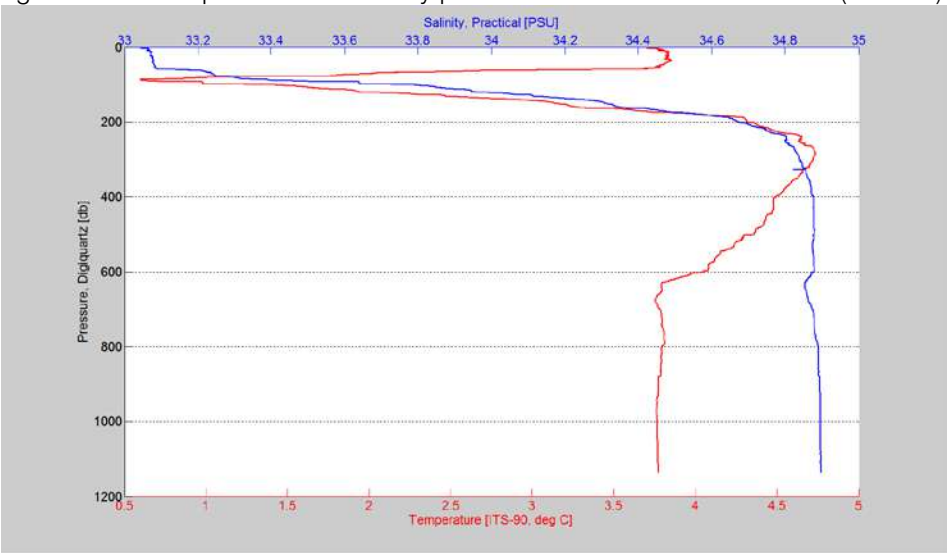

Figure 37-12 Temperature and salinity plot for rosette station DFO 3 1150 m (Cast 30).

Dive A66: DFO Ridge, 750 m. 1 Aug 2018 (Figure 36.13 and Figure 36.14).

The main objectives of this dive were to video-survey coral and sponge fauna on ridge at 750 m depth, and to collect coral and sponge samples. This dive took place after re-termination of the umbilical cable. During re-termination, the CSSF team noticed that the umbilical fibre tubes were extremely damaged (i.e. crushed). Early during this dive, the team indicated that the cage was spinning again (as in the previous dive) and that it was safer to keep the ROV in the cage for the rest of the dive. Therefore, to keep the system stable, we performed the dive with the ROV in the cage, with no sampling taking place. We were able to have a successful video transect dive, with

a very straight line transect ~700 m long being completed, crossing depths between 694-756 m.

Bottom type was mainly sandy and gravel, with boulders in some parts of the transect. Corals include the solitary scleractinian Flabellum sp. (probably F. alabastrum), the small yellow gorgonian Paramuricea sp., soft corals (Nephtheidae), mushroom soft corals (probably Anthomastus sp.), sea pens Anthoptilum (erect and also lying on sea floor) and Halipteris finmarchica on sandy gravel bottom. Several Halipteris colonies were seen towards the end of the transect/dive. Dead sea pen skeletons were also observed.

Sponges include Asconema sp., Geodia sp., encrusting blue sponges (Hymedesmia sp.), and some unidentified fan-shape sponges. Among fish, we observed redfish (Sebastes spp.), small grenadiers (Family Macrouridae), and small (likely juvenile) skates (Family Rajidae). Other invertebrates include unidentified squat lobsters, sea anemones, and crabs.

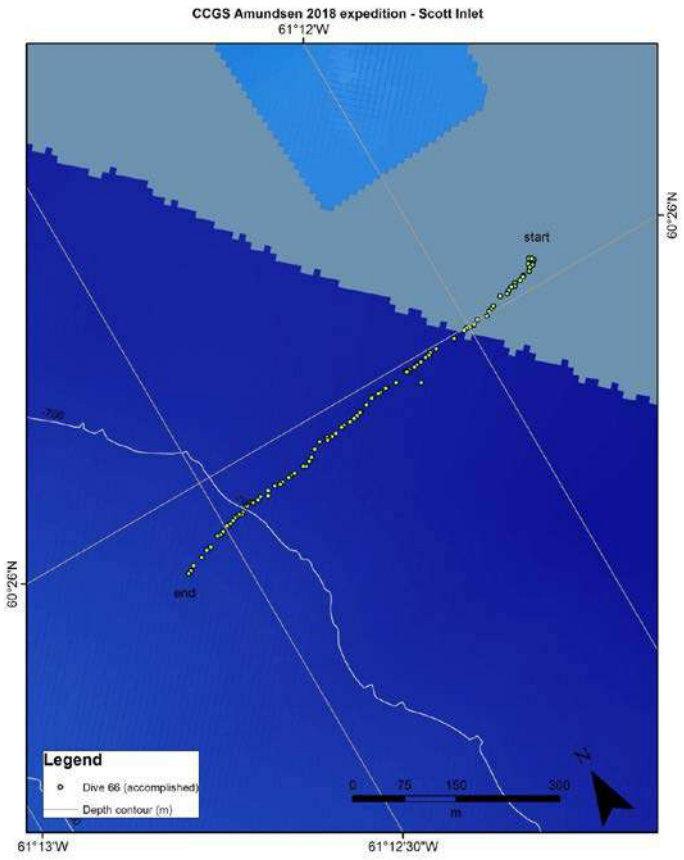

Figure 37-13 Map of the NE Saglek Slope site (ROV dive A66), showing accomplished transect (750-690 m).

This area was potentially impacted by fishing, as lost fishing line was observed on the sea floor, and trawl marks were visible on the sonar and during the transect (video). Furthermore, coral abundance was low, colonies were in the same small size range, and rocks (pebbles and cobbles) appeared sorted into rows in the same orientation as the trawl marks observed on sonar.

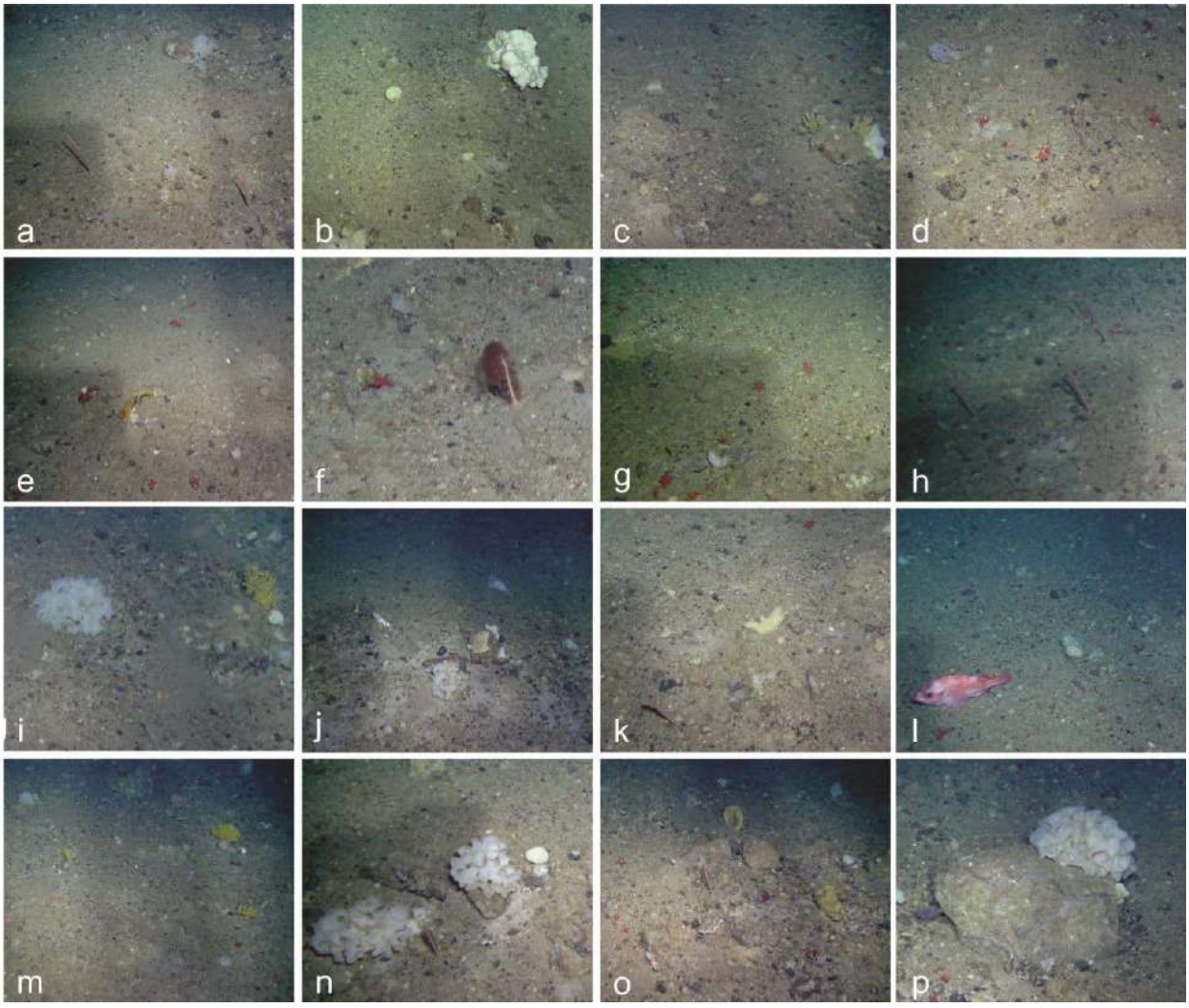

Figure 37-14 Photo-plate of megafauna observed during the Dive A66 ROV video transect at DFO-750-ridge a. *Halipteris* sea pens and small *Asconema* glass sponge; b. *Geodia barretti;* c. small gorgonian corals (*Paramuricea*) and sponges ; d and g. red mushroom corals (*Anthomastus*); e. damaged *Paramuricea* with *Anthomastus* and mushroom corals; f. *Anthoptilum* sea pen and *Anthomastus* mushroom corals; h. cluster of juvenile *Halipteris* sea pens; i. Glass sponge *Asconema* and small *Paramuricea* gorgonian coral; j. Small sponges with juvenile skate; k. sea pen (*Halipteris*), sponge and red mushroom coral (*Anthomastus*); l. *Sebastes* sp. m. small *Paramuricea* gorgonian corals; n. Sponges (*Asconema* sp. and ?*Axinella*) with *Halipteris* sea pen; o. Sponges, sea pens and mushroom corals; p. Large *Asconema* glass sponge with *Duva* soft coral on large boulder.

Dive A67: Hatton Sill, 620 m. 5 Aug 2018 (Figure 36.15 to Figure 36.18).

This dive at the NE Hatton Sill site aimed to survey the "Mercers Monster" site. During this dive we were able to follow a transect 2.5 km in length, with the ROV in the cage, crossing depths of 546-618 m (Figure 36.15). Just before deploying the ROV, we learned that the sampling skid was leaking hydraulics, so that it was not going to be possible to use it to store potential samples

collected during this dive. Nevertheless, one sponge sample could be collected at the end of the dive, and kept in one of the ROV arms, being safely recovered (Figure 36.17).

Bottom type was mainly sand and gravel with occasional boulders (Figure 36.18). Semi-consolidated sand was observed at various points within the dive. Areas of "bare" patches are most likely the result of bottom-contact fishing. Although this area was within the ‘voluntary’ closure (May 2007 onward), fishing continued within the boundaries of the closure based on coral/sponge bycatch documented by Fisheries Observers and Vessel Monitoring Data.

Corals observed during this dive include Primnoa resedaeformis (including dead skeletons), sometimes large Primnoa colonies (e.g. 1 m tall). Primnoa were observed on boulders, both alive and dead skeletons. Soft corals were abundant, likely Duva florida, as well as mushroom corals (probably Anthomastus sp., which could be noticed when the ROV was closer to the bottom). Paramuricea spp. gorgonians were quite common, and were always small. The gorgonian Paragorgia was also observed, both live and overturned. Radicipes sp. (probably R. gracilis) was observed in a number of patches throughout the dive, standing alone on bare sediment patches as well as within dense Geodia sponge patches. Although Radicipes sp. has been reported from depths of ~380 m in the Newfoundland and Labrador region, most previous observations of this species are for average depths of ~1000 m. Furthermore, Radicipes sp. colonies are rare in northern latitudes from NAFO division 2J (~55°20’ N) upwards. Sea pens were also observed, but were not common, including Halipteris finmarchica and Pennatula cf. grandis. Sponges include Asconema sp. (abundant in certain parts of the dive) and several Geodia spp. (G. barretti based on external morphology - naked surface and the presence of preoscules).

In the deeper portions of the dive, it seemed that Asconema sp. was more common than Geodia spp. Other sponges include potential Mycale sp. individuals, Astrophorid sponges, Craniella sp., and the blue sponge (likely Hymedesmia sp.). Sponges were more commonly observed than soft corals in some parts of the dive.

The shallow portions of the dive appeared to be a sponge-dominated system, with spicule mats observed, and sponges growing atop other sponges. This resembles the “ostur” facies described from the northeast Atlantic. Astrophorid sponges dominate in the shallow portions of the dive. Some of the yellow encrusting sponges were seeing covering the astrophorid sponges - most likely Stryphnus fortis with yellow encrusting epibiont sponge Hexadella dedritifera (see Cárdenas 2016). Near the end of the dive, we returned into the dense sponges area, dominated by astrophorids. One Geodia sp. sponge was sampled and kept in the ROV arm (Figure 36.17).

Other invertebrates include abundant sea anemones (Actinauge sp.?), squids, sea urchins, yellow sea stars (Henricia sp.), unidentified octopus, crabs, and squat lobsters. Not a lot of echinoderms were noticed at this site. See Figure 18 for examples of the fauna/bottom observed during this dive.

This site was not very rich in fish. Fish observations include grenadiers (next to abundant soft corals), young skates, sculpins, and Redfish. No obvious trawl marks were seen in the sonar

during this dive. However, there were bare patches of sea floor next to dense concentrations of Geodia fields (Figure 36.18 d and j), which in our experience, might be an indication of a bottom previously physically impacted by bottom-contact fishing gear. The site was not that very different from the Saglek Bank area surveyed during dive A64.

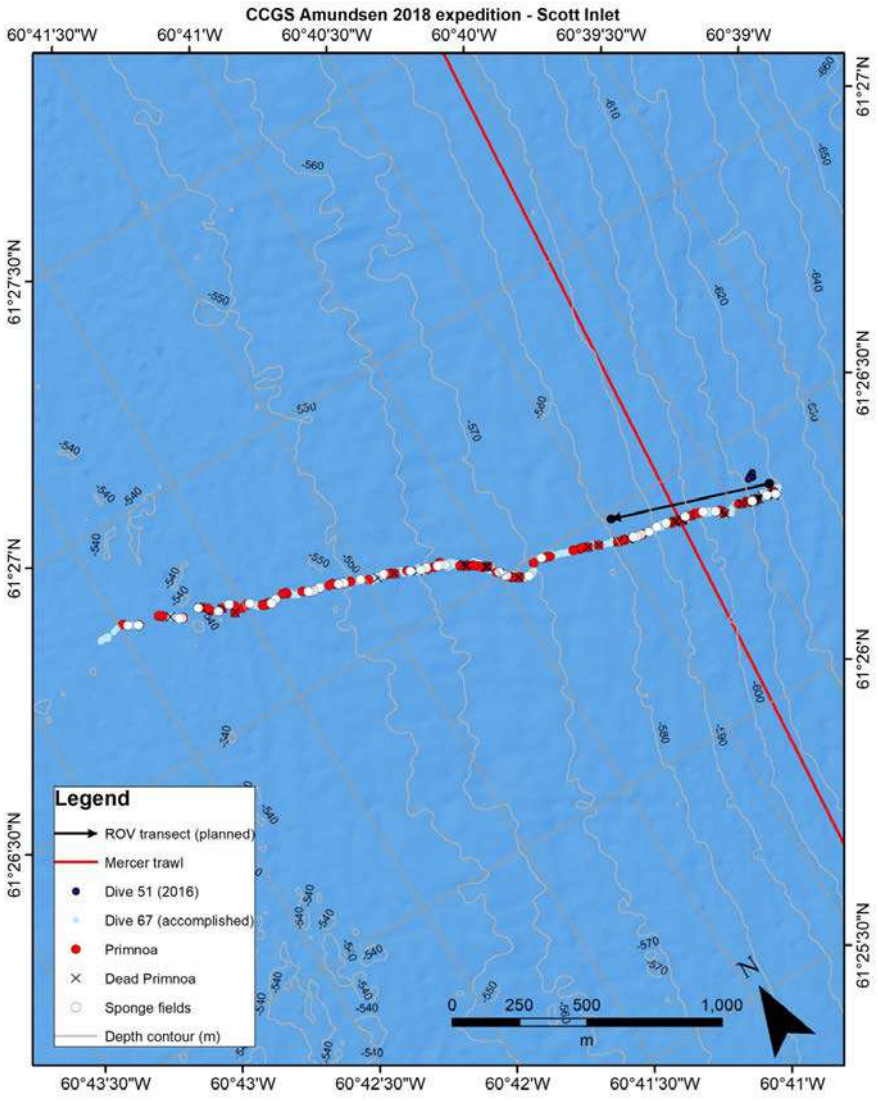

Figure 37-15 Map of dive A67, showing planned and accomplished transects. Contour interval 10 m.

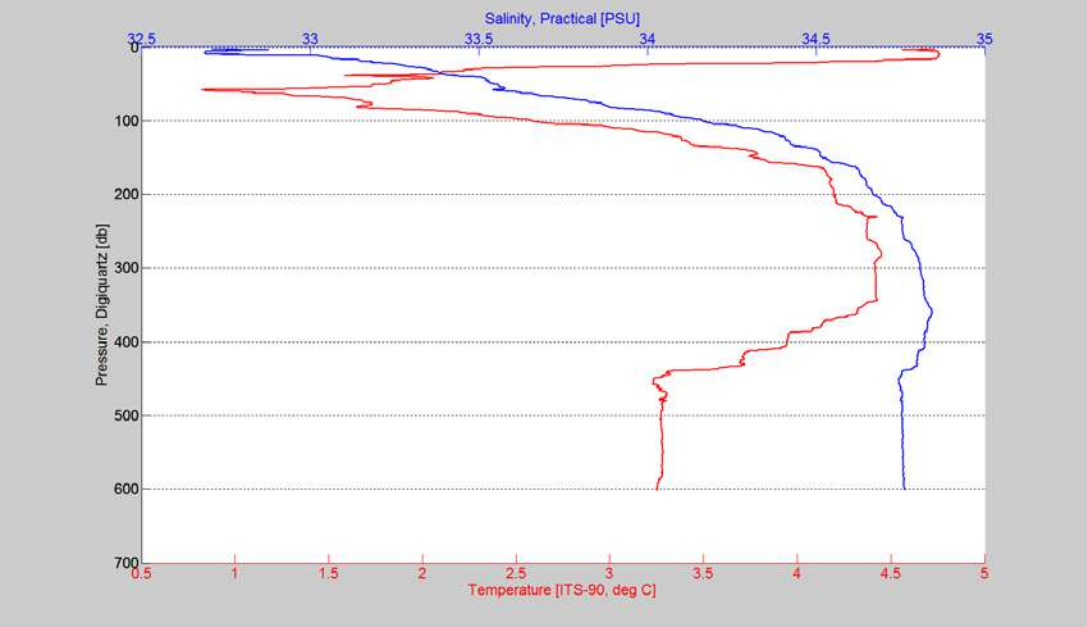

Figure 37-16 Temperature and salinity plot for Hatton Sill (position at start of dive, depth ~620 m).

Figure 37-17 Sponge successfully sampled, kept in the ROV arm (port side), and safely recovered during dive A67.

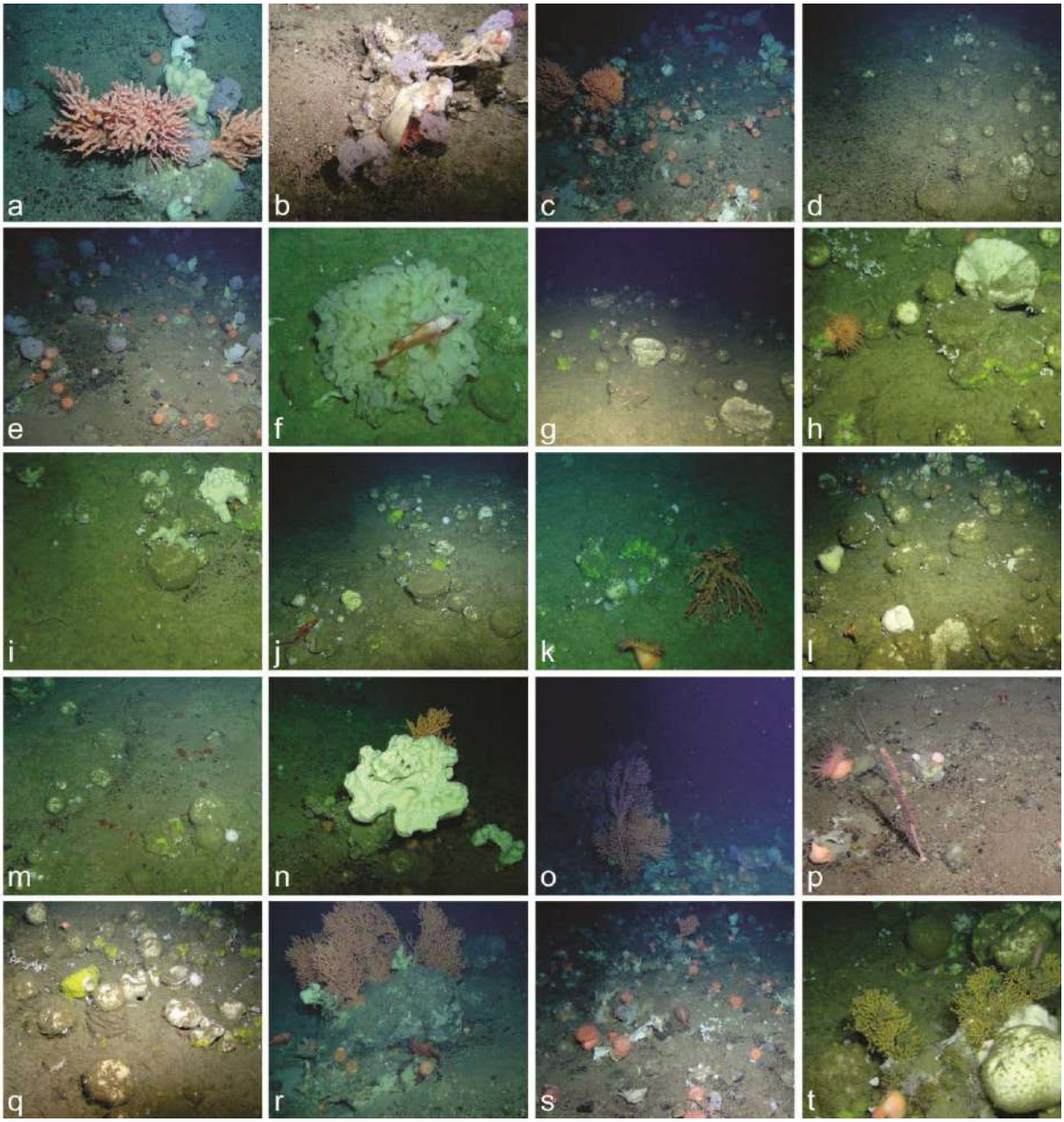

Figure 37-18 Photo-plate of megafauna observed during the ROV video transect at Hatton Sill (dive A67) *a. Primnoa*, *Duva florida*, *Mycale* sp. on boulder; b. Dead *Primnoa* skeleton with sponges and *Duva* corals; c. *Primnoa resedaeformis*, soft corals, sponges and sea anemones; d. Dense *Geodia* sponge field (right) adjacent to bare ground impacted by fishing; e. *Duva* and sea anemones; f. Large *Asconema* glass sponge with *Sebastes* sp.; g-h. *Geodia* sponge fields including *G. barretti*, *G.* cf. *macandrewii*, and epibiont *Hexadella* cf. *dedritifera* (yellow sponge); i. *Geodia* sponges and *Radicipes* sp.; j. Impacted (top left) sponge communities; k. Sponges next to recently impacted *Paragorgia* colony; l. Dense sponge grounds; m. *Geodia* sponges with red mushroom corals (*Anthomastus*); n. Large *Geodia barretti* (1 m in diameter) with *Primnoa resedaeformis;* o. *Primnoa resedaeformis* and *Paragorgia arborea* on boulders; p. *Halipteris finmarchica* sea pen with small juveniles (circled); q. close view of *Geodia* sponge community. Note sponges growing on other sponges.; r. Sponges and *Primnoa resedaeformis* growing on top of boulders with dead skeletons at the base (bottom left); s. sponges and *Primnoa resedaeformis* with one *Pennatula grandis* sea pen (centre); t. Small *Paramuricea* colonies living among *Geodia* sponges.

Dives A68 and A69: SW Greenland Lophelia site, 2 dives (Figure 36.19 to Figure 36.25)

The main purpose of these two dives was to investigate the distribution and nature of Lophelia pertusa stony corals at the site where they were reported in 2017. These corals were discovered accidentally in 2012, when the corals were caught on a CTD rosette during the eastern-most cast of the AZOMP (Atlantic Zoning Off-Shelf Monitoring Program) mission, Labrador – Greenland line. Since that discovery, the site has been investigated by drop-camera (2012, reported in Kenchington et al. 2017), and mapped (Maria S. Merian, Aug. 2017). Furthermore, in 2017 the British research ship RRS Discovery mapped other submarine canyons along the coast of SW Greenland and carried out several ROV dives in which they found live and subfossil solitary corals and colonial corals (RRS 081).

During this mission, the two ROV dives (A68-A69) investigated Lophelia pertusa and other coral distributions in the highly dissected eroded bedrock seascape between about 750 and 950 m water depth. Both dives spent little time on the shallower glacial deposits found on the shelf in waters shallower than 750 m. These habitats were investigated using a 30-minute drop video transect on the evening of 6 Aug using DFO's drop camera system. The Lophelia occurrence has been called a reef, so one of the objectives of the dives was to establish the nature of carbonate buildups at this site, with the hope of identifying coring targets with which to determine its age.

The two ROV dives carried out at this location were hindered by high sea state and by ROV condition. There was 1-2 m swell which caused considerable heave on the ROV umbilical cable, such that it was too risky to move the ROV out of the cage. The ROV umbilical cable has suffered considerable damage over the years, such that the ROV video frequently blacked out when the cable was stretched or was pinched by the rollers where the cable re-enters the ship through the moon pool. This loss of video and telemetry made it even more dangerous to exit the ROV from the cage, due to the risk that it would be impossible to return the ROV to its cage, and the entire ROV could be lost against the steep bedrock walls.

Therefore both dives were carried out in ROV drop-camera video mode, with the ROV remaining in its cage, and using the thrusters to prevent the cage from hitting the steep rock walls. This limitation prevented us from collecting samples of the corals, which had been one of our chief objectives. Bottom currents at this site were very strong. The laterally deployed LADCP on the CTD-rosette measured currents as strong as 60 cm/s in the 3-500 m range, decreasing toward the bottom. Dominant currents were from the Southeast. The currents, combined with the steep bathymetry, may cause topographically-induced upwelling at this site, which could help to support the high abundance and richness of corals, sponges, other invertebrates, and fishes observed at this site.

The bedrock walls appeared to follow the regional structural trend, with walls dipping steeply to the Southwest, parallel to the trend of block faults (Figure 36.21, Dive A68-a and h). Vertical and near-vertical joints were observed frequently in the rocks. Few fresh surfaces of the rocks were observed, where the rock surface was not encrusted by corals, sponges, or other biota. At these fresh surfaces, the rock appearance is consistent with a granite or high-grade metamorphic rock.

The regional geological maps indicate Palaeoproterozoic Julianehaab igneous complex dominated by felsic magmatic rocks and an intrusive complex of possible Mesoprotezoic age (Steenfelt et al., 2016). Bedrock exposures are highly angular, as are cobbles and boulders observed in the glacial deposits occurring shallower than 750 m.

Lophelia pertusa coral colonies were observed on steep bedrock surfaces between 950 and 750 m water depth. The maximum depth of observation was 950 m, so it is quite possible that the corals extend to greater depths. The multibeam bathymetry of the region suggests that steep bedrock exposures continue well below 1000 m. Colony morphologies ranged from globular (Figure 36.23 A69-o under overhangs) to shelf-like (Figure 36.21, A68-d; Figure 36.23, A69-d, p), and occurred on vertical, steeply sloping, or overhung bedrock surfaces. Lophelia colonies appeared to be most abundant on bedrock walls facing to the Southeast, into the direction of the prevailing currents, which were quite strong.

Where bedrock ridges and pinnacles were observed, the opposite sides of these ridges had strongly contrasting fauna, with Lophelia and large gorgonians dominating the Southeast-facing walls, and nephtheid soft corals dominating the Southwest- and Northwest-facing walls (Figure 36.21 A68-b; Figure 36.23 A69-c).

Many of the Lophelia colonies observed had a downward-sloping shelf-like morphology, with live portions of the colonies in the lower and outer-most portions of the colonies, often facing downward (Figure 36.23 A69-p). The shelf-like colony morphology appeared to be more prevalent on the northernmost of the two dives, dive A69. Other colonies with live tissue in all orientations were more common on the first dive, A68, closer to the location where Lophelia was first caught on the CTD in 2012.

Dead Lophelia rubble was commonly observed on rock ledges on steep bedrock walls between 750 and 950 m (Figure 36.23 Dive 69-l, r). Rubble piles often included both living and dead fragments of corals (Figure 36.21 A68-j; Figure 36.23 A69-k) along with a diverse array of associates (Figure 36.23 A69-l). No vertical carbonate buildups, of one Lophelia colony growing on the top of a previous colony or rubble pile, were observed. We suspect that down-slope transport of Lophelia rubble continues until the bottom slope decreases, below 1100 m, according to the MS Merian multibeam sonar data collected in 2017.

Other coral and sponge fauna observed on the bedrock walls included abundant large colonies of the gorgonians Paragorgia arborea (Figure 36.21 A68- f and h) and Primnoa resedaeformis with the latter considerably more abundant (Figure 36.23 Dive 69-b and f).

Sponges included small to medium sized colonies of Geodia (G. barretti?), the common glass sponge Asconema sp., and a wide variety of smaller and encrusting sponges that completely covered wall surfaces (Figure 36.21, Dive 68-i, l, t). Relatively uncommon corals on the rock walls included at least one colony that appears to be the scleractinian coral Madrepora sp., but careful video analysis is needed in order to confirm this record. Rare colonies of unidentified bamboo corals (Figure 36.23, Dive 69-s bottom centre) and cf. Stylaster sp. were also observed.

Surprisingly, the nephtheid soft corals (likely) Duva florida, and the mushroom corals Anthomastus spp., appeared to be common on horizontal or gently sloping surfaces, such as the tops of bedrock pinnacles (Figure 36.23 Dive 69-e). Nephtheid soft corals were also relatively common on the glacial deposits above the vertical bedrock walls. Soft corals in this location seemed much taller than those we have observed in other locations, with colony sizes reaching >30 cm in expanded state.

Other common invertebrates on the bedrock walls included the bivalve Acesta sp. (Figure 36.21 A68-k, n, t; Figure 36.23 A69-g, i), which is commonly found on steep bedrock walls and in Lophelia reef systems elsewhere. Fish fauna included cusk (Family Gadidae), white hake (Urophycis tenuis), redfish (Sebastes spp.; Figure 36.21 A68-f cf. Sebastes norvegicus), and wolfish (Anarhichas cf. lupus), plus a number of other fish that were less obvious and less common. Several examples of each of these species were observed, with one wolffish in a rock crevice that may have been a nest-site den (Figure 36.21 A68-q). Many of the fish appeared to be unusually large and exhibited territorial behavior by charging the ROV (i.e. Figure 36.21 A68-f). Their large size could be related to high productivity at this site, or to a lack of fishing mortality due to the inaccessibility of this site due to its steep bathymetry and strong currents. This Lophelia-rich system may have escaped human impacts due to its steep bathymetry, which renders it highly inaccessible to most bottom-tending fishing gear.

Water productivity

Four 30-minute Manta trawl transects for microplastics were conducted prior to Dive A68 (Figure 36.30), with abundant copepods captured along with two juvenile rocklings. During both ROV descents, water was turbid with abundant comb jellies (Phylum Ctenophora).

Additional geological observations

Although most of our ROV diving operations and time were dedicated to the steep bedrock walls, ROV and drop-camera observations of the glacial deposits between 750 and 700 m water depth revealed some interesting observations. The glacial deposits are mostly gravelly sand, with cobbles and boulders. Particularly at the more northerly site of Dive A69, erosional scars in the glacial deposits were observed, with arcuate slump-like head-scarps observed cutting into apparent crusts within the unconsolidated sediments (Figure 36.23 A69-q-t). These crusts are likely authigenic carbonate crusts, but not associated with hydrocarbon seeps. Southwest Greenland has been reported to have abundant authigenic carbonate crusts, which are formed by the interaction of water rich in organic carbon with pore fluids rich in dissolved calcium carbonate (Sun and Turchyn 2014; Steenfelt et al. 2016).

Multibeam mapping of a small submarine canyon about 6 nautical miles north of the Lophelia dives revealed two small submarine landslides. The slumping observed in the glacial deposits at the upper end of dive A69, combined with the evidence of slope instability at submarine landslide sites suggests that sediment delivery from the unconsolidated glacial deposits onto the steep bedrock wall habitats is quite abundant. It may be that sedimentation from localized erosion of

the glacial deposits may be a limiting factor for distribution and abundance of Lophelia at this location. Furthermore, the prevalence of the sloping shelf morphology of Lophelia at dive A69 (Figure 36.23 Dive 69-d, k, o, and p), and non-observation of the globular colony morphology observed at dive A68 may be tied to sedimentation from down-slope transportation of eroded Quaternary glacial material.

Emerging questions

We have yet to find evidence that would indicate the age of inception of this Lophelia community. The age of this ecosystem may be an indicator of changing strength of the West Greenland current during the Holocene, or may be tied to other oceanographic or geological factors. The processes leading to formation of apparent authigenic carbonate crusts in the glacial deposits, and the age of those crusts, also remain unknown.

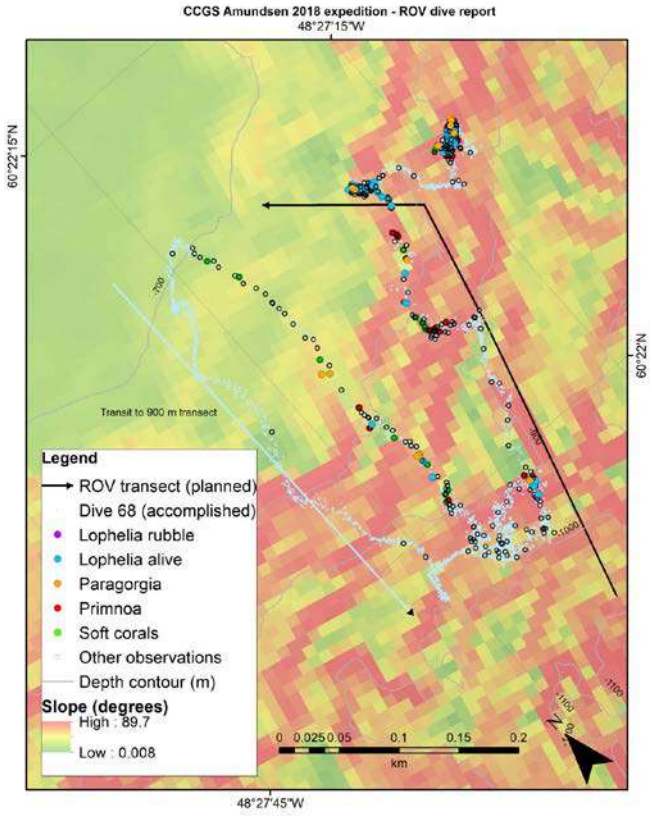

Figure 37-19 Map of dive A68, the first dive at the SW Greenland Lophelia site, showing the placement of the dive transects over the multibeam slope raster. A preliminary distribution of corals observed during this dive is also shown.

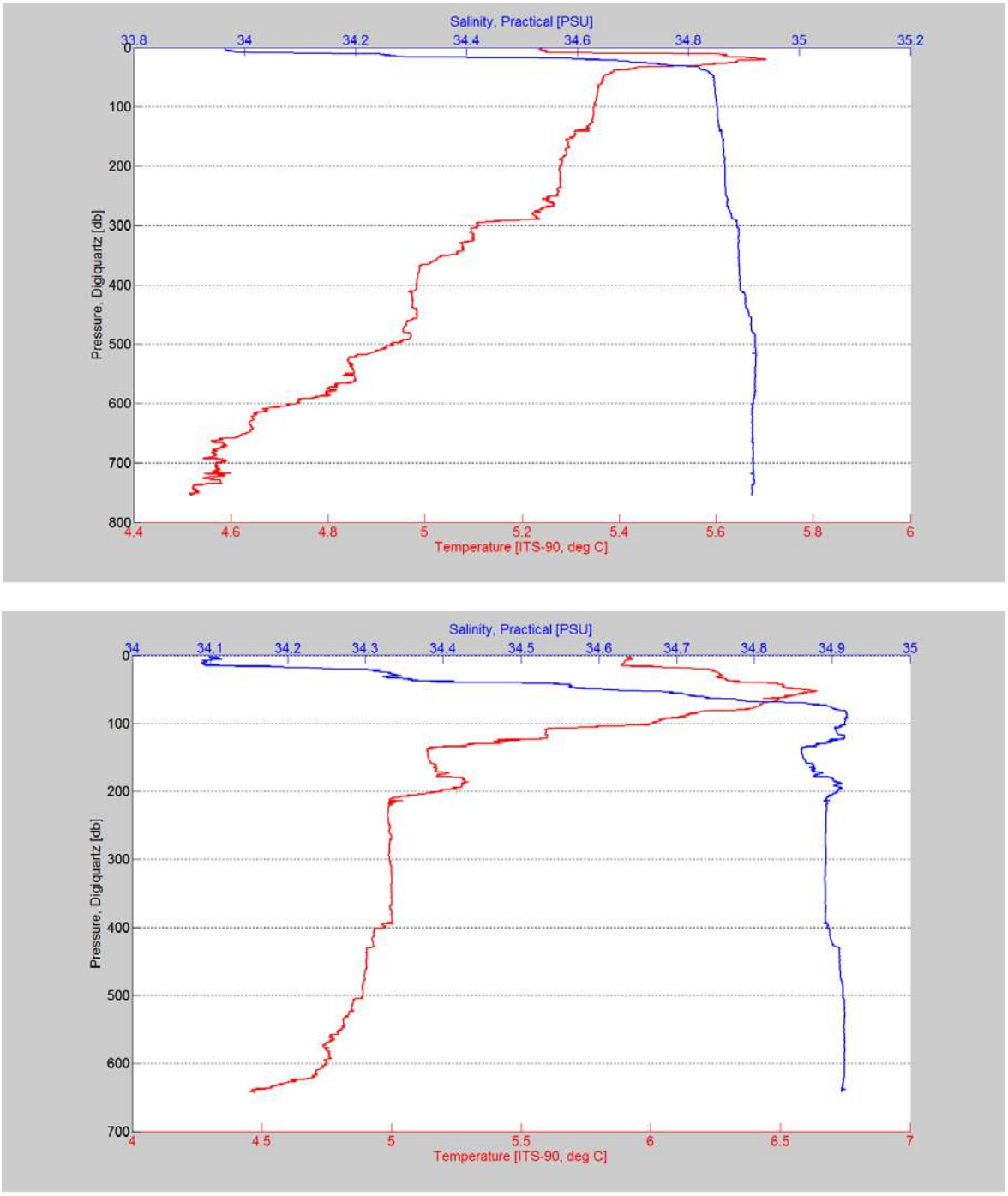

Figure 37-20 Temperature and salinity plot for rosette casts 40 (top) and 41 (bottom) for Lophelia site

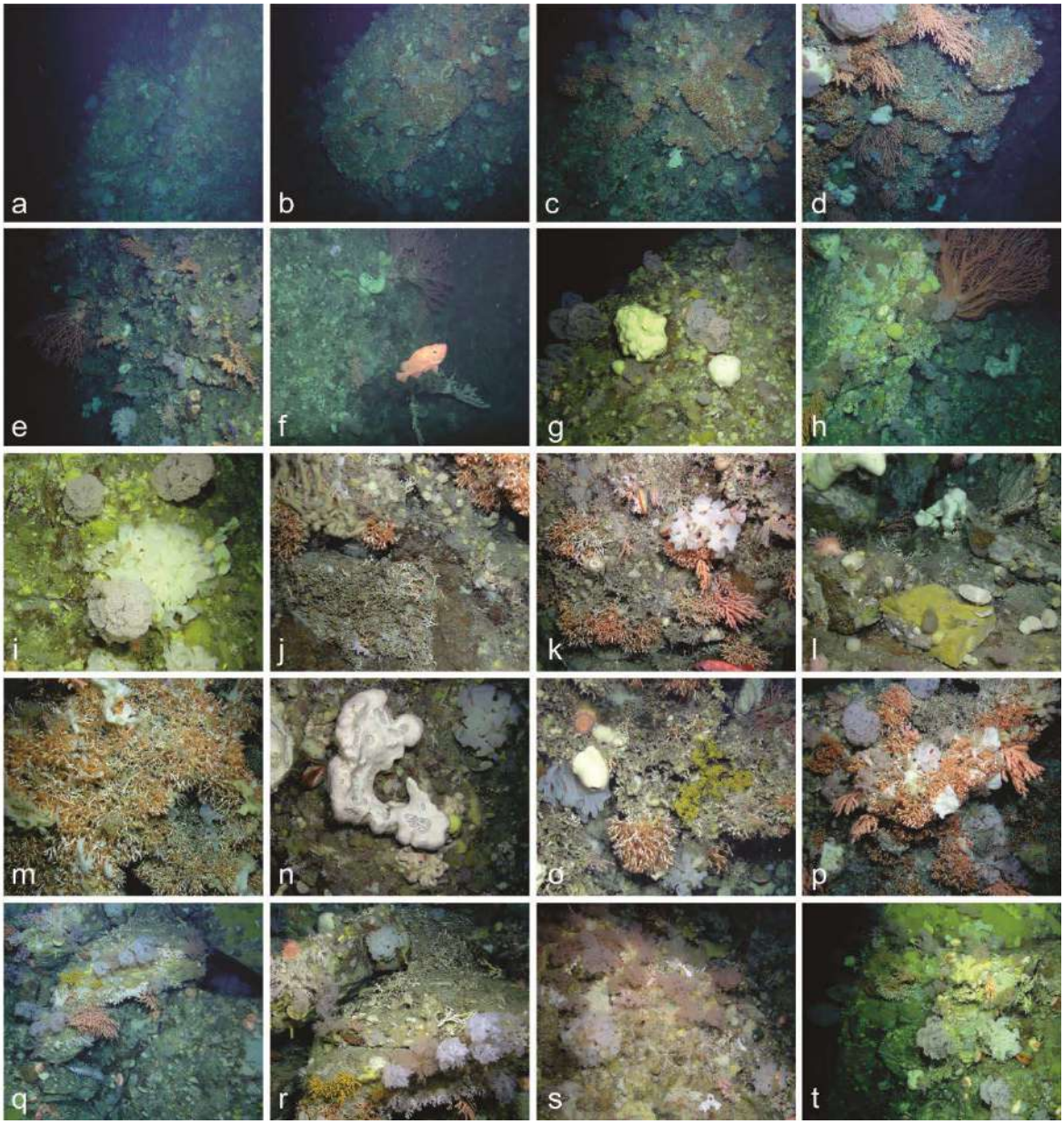

Figure 37-21 Photo plate, Lophelia dive 1
a-d. Steep band angular bedrock surface is covered with fauna including large gorgonian and colonial scleractinian corals and sponges. Note the loose block in figure a. e. Large gorgonian corals and glass sponges – note they grow from crevices in the faulted blocks.; f. Large redfish (*Sebastes norvegicus*) exhibiting territorial behaviour, with large *Paragorgia arborea* in the background. g. *Geodia* sponges with large soft corals (?*Duva*); h. Large *Paragorgia arborea* (~1.5m) with *Primnoa*, soft corals and encrusting sponges. Note the joints in the bedrock.; i. White glass sponges and yellow encrusting sponges with large soft corals.;j. *Lophelia* colonies above ledge filled with dead fragments; k. *Lophelia* colonies with glass sponges and *Acesta* bivalves; l. Sponge fauna colonizing rock wall, ledge and loose boulders of bedrock. m. *Lophelia* colony with sponge associates; n. Wall encrusted with a large *Geodia barretti* sponge among other sponge species; o-p. *Lophelia* colonizing a over hang with colonial zoanthids (yellow), gorgonians, sponges and other fauna.; q. Rock wall fauna with wolffish (top right) and cusk (bottom left); r. Faulted bedrock with dead *Lophelia* rubble on the upper surface and living sponges and corals on the lower surfaces; s. Soft corals with glass sponge (*Asconema* sp.?) and bamboo coral (centre); t. Rock wall fauna some growing in the crevices others on the more exposed surfaces.

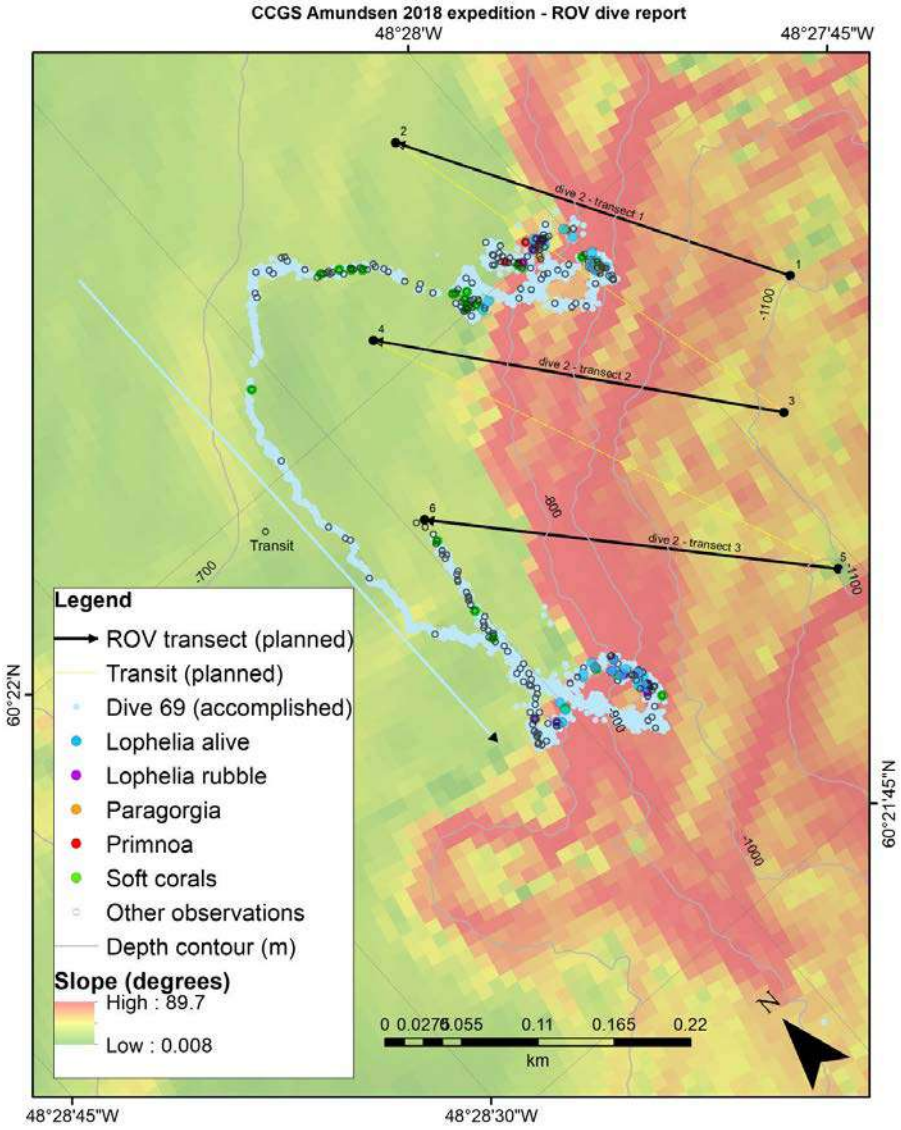

Figure 37-22 Map of dive A69, the second dive at the SW Greenland Lophelia site, showing the placement of the dive transects over the multibeam slope raster. A preliminary distribution of corals observed during this dive is also shown.

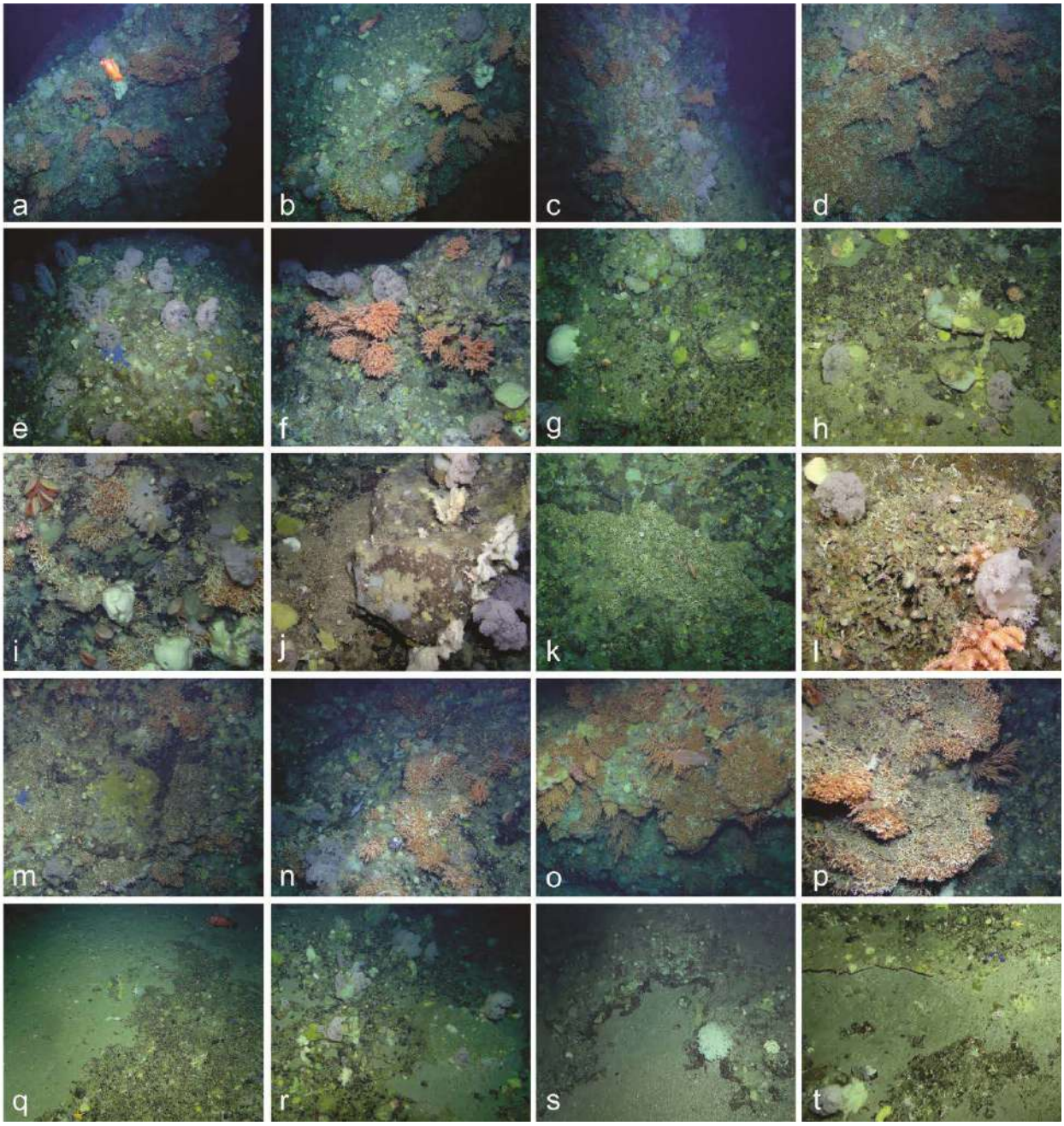

Figure 37-23 Photo-plate of megafauna observed during the ROV video transect at Lophelia site 2
a–c. Two aspects of the rock wall pinnacle with different fauna on each side - soft corals on the left side and gorgonians and *Lophelia* on the right. Note the small Cephalopod swimming in front of the ROV camera (a) and redfish (b). d. Lophelia colonies on overhung bedrock.; g–h. Poorly sorted sand and subangular gravel on sloping shelf break above bedrock cliffs.; i. Sponges and soft corals growing on a loose block; k. *Lophelia* coral rubble on the foot of the rock wall; m *Lophelia* coral rubble on ledges and crevices in the bedrock; q–t. Erosional scars in the glacial deposits on the slope, cutting into the slightly cemented crust, possibly authigenic carbonates.

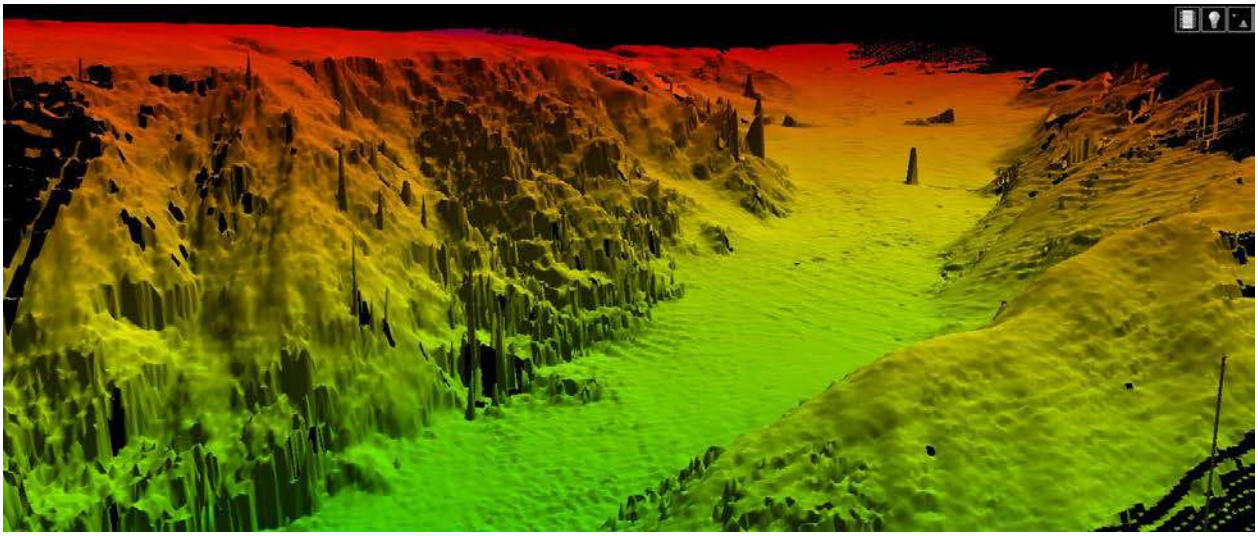

Figure 37-24 3D-bathymetric model of bathymetry near Lophelia sites 1 and 2
The vertical exaggeration on this image is 1, that is, there is no vertical exaggeration. The *Lophelia* occurrences are on the steep bedrock walls in centre-left. The shallowest water shown at the top of the shelf –break is approximately 600 m, while the deepest water shown in the thalweg of the canyon is about 1700 m. The large canyon to the south of the *Lophelia* site was considered as a gravity coring target to look for evidence of *Lophelia* rubble in sediments, but sub-bottom profiling did not yield convincing evidence of a soft bottom, so the gravity coring operation was cancelled. Image by hydrographic intern Luca Arduini-Plaisant.

Other activities at this location

Two CTD-rosette casts, drop-camera tow at 650-700 m on the shelf-edge, four surface trawl transects for microplastics, one monster-net vertical plankton tow, and about 10 hours of multibeam sonar mapping and 3.5 kHz sub-bottom profiling were carried out at the Lophelia site. The DFO drop camera tow along the shelf break showed that the bottom was too rough for either box-coring of Agassiz-trawling (Figure 36.25).

We considered a gravity core at about 1600 m in the thalweg of the canyon immediately south of the Lophelia occurrence at dive A68, but the sub-bottom profile of the prospective gravity coring site did not indicate laminated muddy sediments, so this gravity coring station was abandoned.

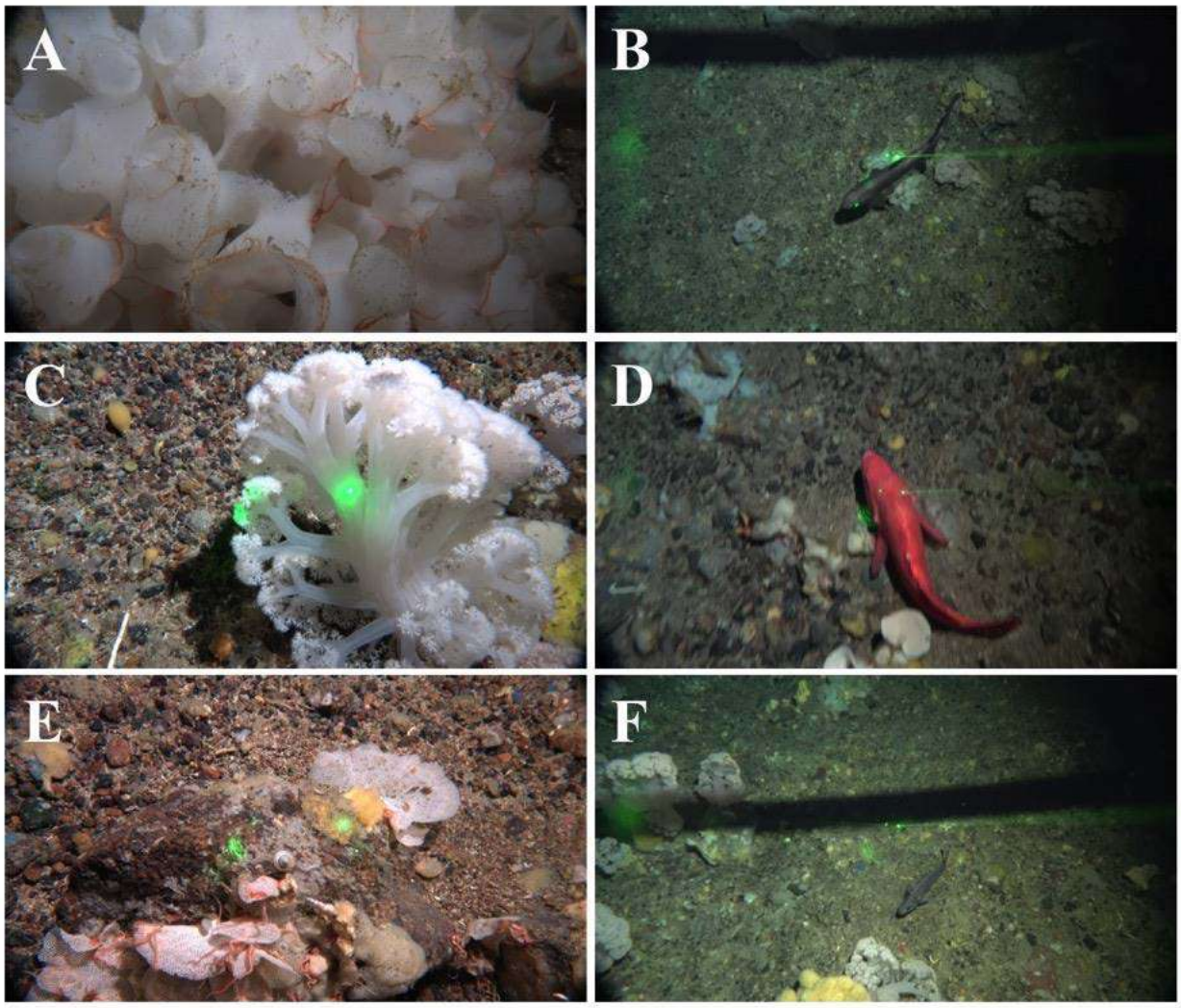

Figure 37-25 DFO drop-video camera images from about 630 m depth, on the sloping shelf break above the steep bedrock walls that support Lophelia growth. A: Asconema sponges. B: black dogfish or lantern shark. C: soft corals. D: Redfish. E: bryozoans and small anemones. F: gadoid fish on gravelly bottom.

Dives A70-A72: Scott Inlet. 12-13th August 2018. (Figure 36.26 and Figure 36.27)

Three ROV dives (A70-A72) were conducted at Scott Inlet with the main objectives of identifying signs of a seep environment (e.g. bubbles and bacterial mats), and collecting sediment samples from seep versus non-seep sites (Figure 36.26). These dives were directed by Dr. Casey Hubert's team aboard, therefore only a general overview of these dives is given in this report.

In preparation for these dives, the damaged umbilical cable went through a second re-termination, with an additional ~650 m of the cable being removed. As a result, all three dives at this site were quite successful, with the ROV being able to leave the cage and to collect high quality video data, sediment, coral, and sponge samples (Figure 36.27). The dives took place at

depths ranging between ~260-275 m. Approximative transect lengths were ~300 m (A70) and ~950 m (dive A72).

Bottom type was mainly gravelly with occasional boulders (Figure 36.27). Bubbles were seen coming from the bottom at a few instances during dive A70, the general location identified as a seep location in 2013. The other two dives took place at sites further way from the initial seep location (at 1 and 5 km), and although bacterial mats were still seen during dive A71 (transect dive in the direction of the site surveyed during dive A70), they were no longer observed during dive A72 (no transect, only sampling at 5 km from the initial site in dive A70). Sediment samples were collected using the spatulas attached to the ROV arms and placed in a bucket positioned in the sampling skid (Figure 36.27).

The only corals observed at this site were soft corals (Nephtheidae), and a few sponges were also observed. Crinoids and ophiuroids were the most conspicuous invertebrates at this site (Figure 36.27). Shrimp and basket stars (Gorgonocephalus sp.) were also observed. Shrimp were particularly noticed near the bacterial mats. The video observations matched quite closely the catch from an Agassiz trawl deployed at this site. Fragments of the gorgonian Paramuricea sp. were found in the Agassiz trawl, but the non-observation of this gorgonian during the video transects, the high latitude (West side of Baffin Bay), and shallow depth are indication of a potential contamination from a previous trawl deployment in the Labrador Sea, where fragments of this coral had been encountered.

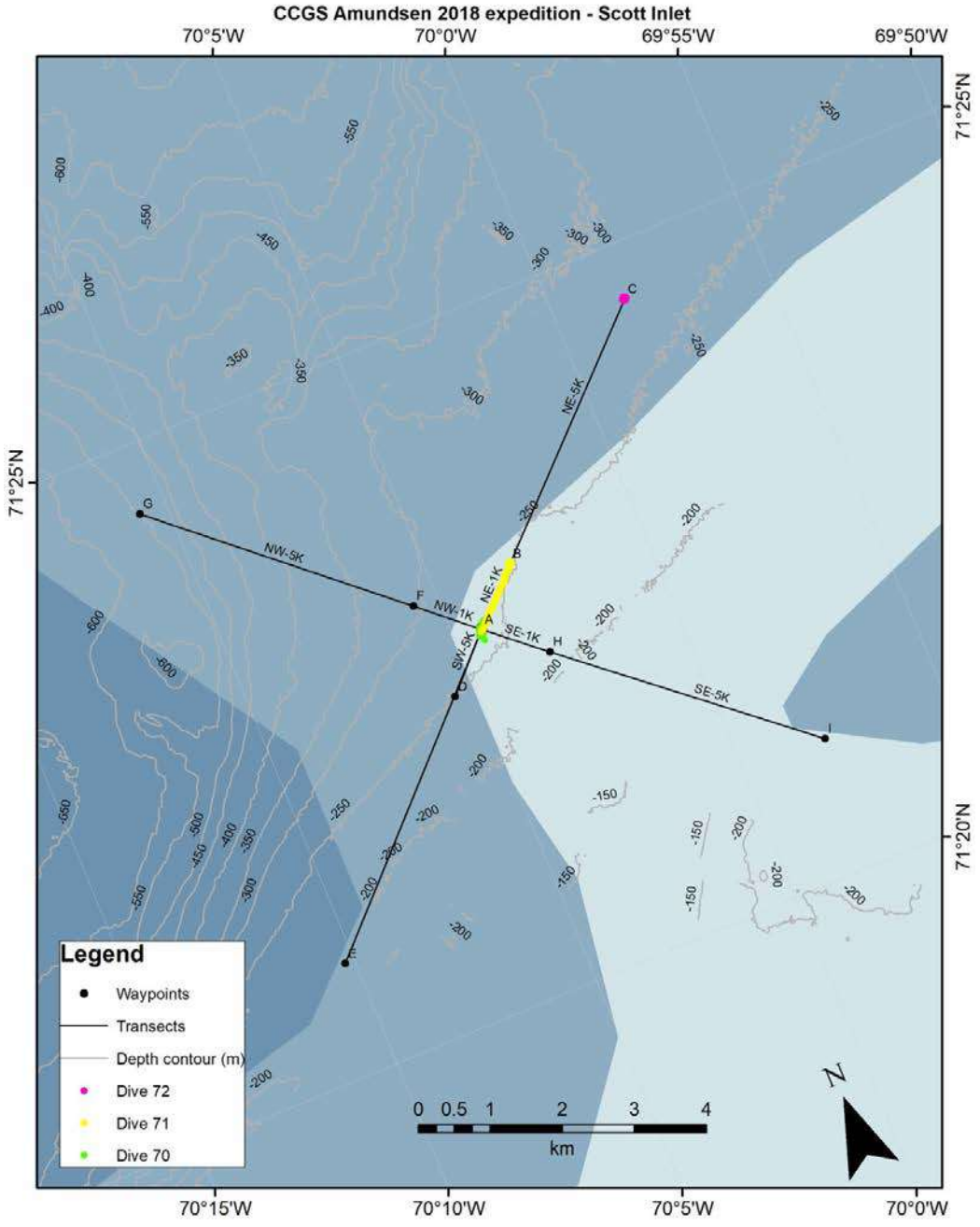

Figure 37-26 Accomplished ROV dives (A70-A72) and rosette (waypoints) sampling design for the Scott Inlet site

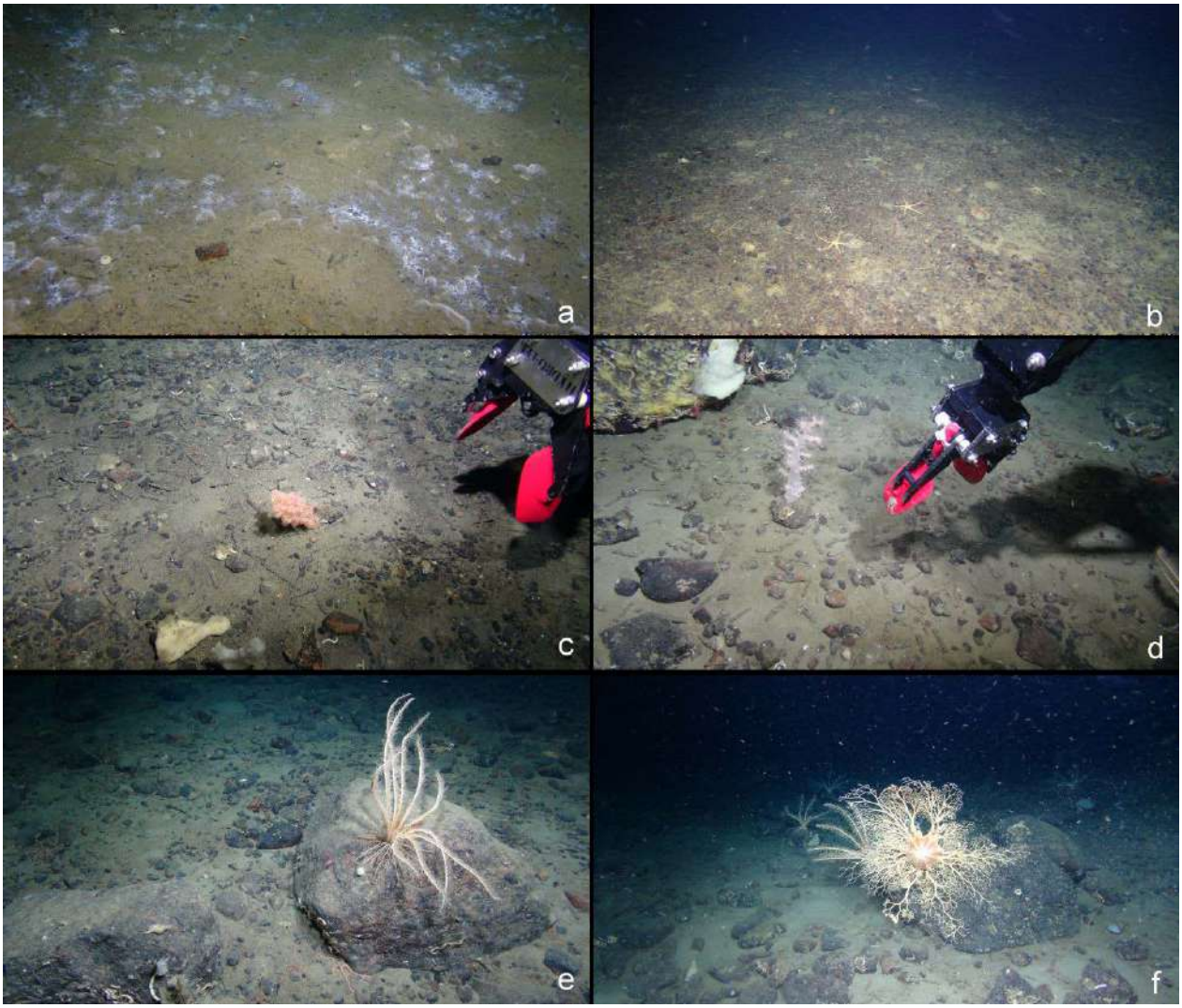

Figure 37-27 Photo-plate of megafauna observed during the ROV video transects at Scott Inlet (dives A70-A72): a. bacterial mat (A70), b) gravelly bottom covered with ophiuroids (A70), c. soft coral Pseudodrifa sp. being collected (A70); d. soft coral Gersemia rubiformis being collected (A72); e. crinoid on boulder (A70); f. the basket star Gorgonocephalus sp. on boulder (A72).

37.4.2 *Gravity core at Disko Fan. 10 August 2018 (Figure 36.28 and Figure 36.29)*

The bamboo coral forest at Disko Fan acts to trap sediment among the branches of the corals, acting as ecosystem engineers that modify their surrounding habitat. Piston cores, and especially the trigger weight cores for piston cores collected in 2016 found the lowest coral fragments in the trigger weight core immediately above the glacigenic gravels about 1.3 m below the sediment surface. In order to better assess the variability in the age of inception of this biogenic habitat, and the sedimentation rates within and between coral patches, we collected five additional gravity cores from this site.

Gravity cores were selected, rather than piston cores, for three reasons. First, the piston cores in 2016 apparently dislodged the upper muddy portions of their cores, causing distorted

chronologies and making it impossible to estimate actual sediment accumulation rates. Second, similar studies of accretion rates and carbonate budgets of Lophelia reefs have successfully used gravity cores. Finally, the piston coring process aboard Amundsen is quite challenging, time-consuming, and costly.

Five gravity cores were collected (Table 36.2, Figure 36.28). All five were targeted by aiming for the areas of the 2016 ROV video transect through this site that had the highest percent cover of Keratoisis bamboo corals. Three of the cores had dead coral fragments in the sediments at several different levels. One box-core was also collected at this site, which came back with bamboo coral fragments on it. Unfortunately, ice and 25-kt winds prevented the ship from carrying out precisely targeted coring operations (Figure 36.28). The ship aimed for targets within 200 m of the original targets, and in the 850 – 900 m depth range.

The main aims of the study are to collect microfossils (planktic and benthic foraminifera) from the gravity cores, and to reveal the age of the coral ecosystem by means of biostratigraphy. Further, the palaeoecology of the foraminifera can enhance our understanding of this unique arctic ecosystem.

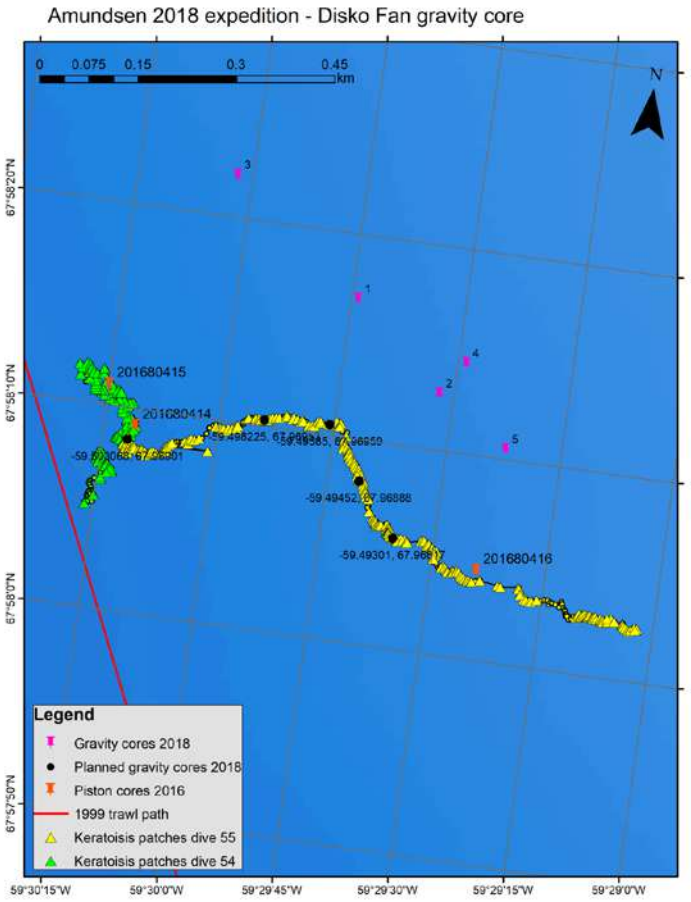

Figure 37-28 Map of Disko Fan gravity cores (bottom position) in relation to Keratoisis coral percent cover as observed in 2016 ROV video transect.

Table 44-2 Gravity cores collected at the Disko Fan bamboo coral forest site during Leg 2c of the 2018 Amundsen expedition

Map ID	Core #	Lat (N)	Long (W)	Depth (m)	Core length (cm)	Observations
1	GC pt 2	67.9674	-59.49488	885	19	Mud above gravelly sand. Corals on core head gear (see Fig. 29), no coral fragments visible in core.
2	GC pt 3	67.97021	-59.49204	880	67	Mostly mud, gravelly sand at base. Dead coral fragments visible in core.
3	GC pt 4	67.97279	-59.50039	893	32	Cohesive mud. Coral fragments visible at 13 and 15 cm below surface
4	GC pt 5	67.97067	-59.49122	875	20	Mud at top, sandy gravel at base. No coral fragments visible.
5	GC pt 6	67.96958	-59.48938	874	83	Muddy at top, sandy below. Coral fragments visible at 30 cm depth
	BC pt 6b	67.97023	-59.49178	882	60	Push core through box core with abundant

Figure 37-29 Bamboo coral (Keratoisis sp.) caught on top of the gravity core (GC pt 2) at Disko Fan. Inset shows close-up of fragments.

37.4.3 *CTD-Rosette Water Sampling Throughout cruise (Table 36.3)*

Water samples for the Hidden Biodiversity team were collected from the CTD-rosette by Shaomin Chen (Dalhousie University) and Karl Purcell (UQÀM) to measure nutrients, characterize the stable isotopic composition ($\delta^{13}C$, $\delta^{15}N$, $\delta^{18}O$, $\delta^{2}H$), and measure carbonate chemistry and methane concentrations in the water column at selected waypoints. The carbonate chemistry measurements taken are total alkalinity (TA) and dissolved inorganic carbon concentration (DIC). Total alkalinity (TA), DIC, water temperature and pressure are used to calculate aragonite and calcite saturation states, which are measured along depth profiles as a measure of ocean acidification. One of our goals is to assess whether aragonite and/or calcite saturation states limit the distributions of corals and sponges.

The resultant data will be used to answer long-standing questions about nutrient availability and transport in the Labrador Sea and southern Baffin Bay. In addition to their value as a robust, standalone chemical oceanographic dataset the isotopic values obtained from these water samples will be related to the biogeochemical signatures of the mineralized and proteinaceous components of deep-sea coral skeletons to develop a historical perspective of environmental change in the North Atlantic and Arctic Ocean.

To further corroborate these data, 30 liters of water (alternating between surface water and bottom water at each site) were collected at each sampling station and filtered on site to yield several milligrams of sinking particulate organic matter (POM) from the water column. Sinking POM is of particular interest to the ArcticNet Hidden Biodiversity team because it is believed to constitute a considerable component of the diet of deep-sea corals. By identifying the isotopic signature of sinking POM we intend to shed light on the feeding habits and subsequent biological fractionation of $\delta^{13}C$ and $\delta^{15}N$ isotopes in the two keystone coral species Primnoa resedaeformis and Keratoisis sp.

Table 44-3 Information on CTD-rosette sampling at ROV and other sites during the 2018 Amundsen expedition. *Several casts were taken in Scott Inlet

Stn	Date	Latitude	Longitude	Depth (m)	pCO_2/CH_4	DIC/TA	Nutrients	NO_3 isotope
9b	26/07	62.67712	-66.48839	485.33	x	x	x	
Sponge Site 5	27/07	60.40044	-62.90011	300.96			x	
Non-sponge Site 5	28/07	59.22465	-61.82626	150.68			x	
Non-sponge Site 4	28/07	59.31119	-61.01718	205.54			x	
Non-sponge Site 2	28/07	59.47487	-59.44245	1961			x	

Non-sponge Site 1	29/07	59.53374	-58.63407	2378.36			x	
Saglek Bank	29/07	60.45298	-61.25635	516.57	x	x	x	x
Sponge Site 4	30/07	60.45967	-62.12046	368			x	
Saglek Deep	31/07	60.4663	-61.10411	1138.11	x	x		
Sponge Site 2	02/08	60.46692	-60.38003	1940.02			x	
Sponge Site 1	03/08	60.46845	-59.25748	2415.08			x	
DFO-9	03/08	60.47102	-58.81319	2489.32	x	x	x	
DFO-11	04/08	60.44128	-57.09002	3026			x	
Hatton Basin	05/08	61.43727	-60.66732	612	x	x		
Lophelia	06/08	60.36968	-48.46247	700	x	x	x	x
NLSE07	09/08	63.2509	-54.1989	1175.29	x	x	x	x
SW Greenland-1	09/08	63.99804	-55.50314	1078.23			x	x
SW Greenland-2	10/08	66.49895	-57.00849	667.45			x	x
Disko Fan	10/08	67.97867	-59.51255	910.6	x	x	x	x
SW Greenland-3	11/08	68.97749	-62.48307	1892	x	x	x	x
Scott Inlet*	12/08	71.37635	-70.07686	215-557	x	x	x	x

37.4.4 *Microplastic Sampling (Table 36.4 and Figure 36.30)*

The Manta trawl was deployed 13 times during Leg 2c of the 2018 Amundsen expedition (Figure 36.30). A total of eight Manta trawl deployments were successful in Frobisher Bay, with one unsuccessful deployment due to sea state conditions. Another four transects took place at the SW Greenland station (Table 36.4). Trawling speed ranged between 2.5-2.8 knots, with the trawl being constantly monitored for adequate positioning and water flux.

Samples were collected using individual cod-ends at each deployment and preserved frozen due to the presence of organic material. We used petri dish with double sided tape to create a contamination sample per day of deployment. We took samples from mittens, gloves, scarfs, toques, jackets, and other fabrics of personnel working on deck in contact with the trawl to ensure any potential contamination can be identified. Samples will be analyzed by Dr. Max Liboiron (Memorial University of Newfoundland).

Figure 37-30 Manta trawl deployment for microplastic sampling in Frobisher Bay during Leg 2c of the 2018 CCGS *Amundsen* expedition.

Table 44-4 List of stations where the Manta trawl for microplastics sampling was deployed during Leg 2c of the 2018 CCGS *Amundsen* expedition.

Date	Station	Location	Trawl_ID	Speed (kn)
25-07-2018	Inner Bay	Frobisher Bay	1	2.8
25-07-2018	Inner Bay	Frobisher Bay	2	2.8
25-07-2018	Inner Bay	Frobisher Bay	3	2.8
25-07-2018	Inner Bay	Frobisher Bay	4	2.8
25-07-2018	Outer Bay	Frobisher Bay	5	2.8
26-07-2018	13C	Frobisher Bay	6	2.8-2.5
27-07-2018	-	Frobisher Bay	-	2.8
27-07-2018	15C	Frobisher Bay	7	2.8
27-07-2019	15C	Frobisher Bay	8	2.8
06-08-2018	Lophelia	SW Greenland	9	2.8
07-08-2018	Lophelia	SW Greenland	10	2.8
07-08-2018	Lophelia	SW Greenland	11	2.8
07-08-2018	Lophelia	SW Greenland	12	2.8

37.4.5 *Corals, zooplankton, sediment, and water sampling for stable isotopic/lipids/fatty acids analyses*

Corals, sediment, zooplankton, and water samples were also collected as part of a study on the functional role of Nephtheidae soft corals (DFO IGS project: Investigations into the functional roles and connectivity of soft corals in continental shelf and slope benthic ecosystems in Newfoundland and Labrador, and Eastern Arctic Regions). Samples of soft corals have been collected during the 2018 Amundsen expedition using Amundsen's ROV, box-cores, and Agassiz trawl. Specimens will be analyzed for C and N stable isotopes and lipids/fatty acids (FA) composition in order to investigate patterns in their trophic ecology. Corals have been subsampled and frozen at -80 °C for lipids/FA analysis and kept in -20 °C for isotopic composition, taxonomy, and examination of associated biodiversity (Table 36.5). A total of 46 coral samples have been collected throughout Leg 2c: 44 from the Agassiz trawl and/or box-cores, and 2 from the ROV (1 dive 71, and 1 in dive 72 in Scott Inlet, Table 36.5). Sponge samples were also kept for species identification (Table 36.5).

Zooplankton, sediment, and water samples were collected in order to better assess their potential as food sources for deep-water soft corals. Zooplankton subsamples were collected from two stations using the Monster vertical net (Hatton Basin and Lophelia sites, Table 36.6). Samples were collected by Thibaud Dezutter (U. Laval). Two 50 ml vials were kept by Bárbara Neves (DFO-NL) and Gustavo Guarin (U. Laval). Sediment samples from 3 stations were obtained from the box-cores using a spoon to collect surface sediment (Meghan Hamp for B. Neves), which was frozen at -20 °C (Table 36.7). Finally, bottom water from 10 rosette stations was collected (~20L/station) and filtered aboard through pre-muffled 47 mm GF-F filters, which were also frozen at -20 °C (Table 36.8).

Table 44-5 Coral and sponge samples collected aboard the 2018 CCGS *Amundsen* expedition with the Agassiz trawl, box-cores, and ROV for lipids/fatty acids analyses (coral team, DFO-NL)

Stn	Gear	sp_id	species	Latitude_start	Longitude_start	Latitude_end	Longitude_end	Depth_start	Depth_end
20d	Agassi	#1	*Drifa glomerata*	62.84962	-66.58355	62.8442	-66.58689	139.97	113.16
20d	Agassi	#2	*Drifa glomerata*	62.84962	-66.58355	62.8442	-66.58689	139.97	113.16
20d	Agassi	#3	*Gersemia rubiformis*	62.84962	-66.58355	62.8442	-66.58689	139.97	113.16
20d	Agassi	#4	*Gersemia rubiformis*	62.84962	-66.58355	62.8442	-66.58689	139.97	113.16
20d	Agassi	-	Sponge sp.	62.84962	-66.58355	62.8442	-66.58689	139.97	113.16
7b	Box-	1	*Gersemia rubiformis*	62.73346	-66.57315	-	-	445.2	-
7b	Box-	1	*Gersemia fruticosa*	62.73346	-66.57315	-	-	445.2	-
7b	Box-	1	*Drifa glomerata*	62.73346	-66.57315	-	-	445.2	-
7b	Box-	1-4	*Gersemia rubiformis*	62.73346	-66.57315	-	-	445.2	-
7b	Box-	1	*Tentorium* sp.	62.73346	-66.57315	-	-	445.2	-
7b	Box-	1	Sponge sp.	62.73346	-66.57315	-	-	445.2	-
7b	Box-	1-4	Bryozoan sp.	62.73346	-66.57315	-	-	445.2	-
R-67	ROV	R67-1	*Geodia* sp.	61.44667	-60.70946	-	-	556.42	-
R-71	ROV	R71-1	*Mycale* sp.	71.38528	-70.05205	-	-	263.2	-
R-71	ROV	R71-2	*Mycale* sp.	71.38528	-70.05206	-	-	263.18	-
R-71	ROV	R71-3	White finger-sponge	71.38528	-70.05209	-	-	263.46	-
R-71	ROV	R71-5	*Pseudodrifa* sp.	71.3852	-70.05227	-	-	264.4	-
R-72	ROV	R72-2	*Gersemia rubiformis*	71.41005	-69.97219	-	-	274.61	-

Box-core and ROV depths are bottom depths.

Table 44-6 Zooplankton samples collected aboard the 2018 CCGS *Amundsen* expedition with the Monster Net (vertical, 500µm mesh) for a coral isotopic study (coral team, DFO-NL)

Station	Date	Lat_start	Long_start	Depth_start_m	Lat_end	Long_end	Depth_end_m
Hatton Basin	05-08-2018	61.44037	-60.66506	612	61.43761	-60.66202	612
Lophelia	07-08-2018	60.3686	-48.45745	656.12	60.37249	-48.47799	625.95

Table 44-7 Sediment samples collected aboard the 2018 CCGS *Amundsen* expedition with the box-core for a coral isotopic study (coral team, DFO-NL)

Station	Date	Latitude_bottom	Long_bottom	Depth_bottom_m

DFO-5-1000m	02-08-2018	60.46839	-60.5849	1424	1 spoon
DFO-7-2000m	02-08-2018	60.4759	-60.37512	1899	1 spoon
DFO-8-2500m	03-08-2018	60.46771	-59.24516	2445	1 spoon

Table 44-8 Water samples collected aboard the 2018 CCGS *Amundsen* expedition with the rosette for a coral isotopic study (coral team, DFO-NL)

Station	Cast	Bot_lat_DDM	Bot_long_DDM	Bottom depth (m)	Date
Saglek Bank DFO-1	26	60 27.024	61 15.046	539	29-07-2018
Sponge site 3 - Atlas	29	60 28.033	61 17.918	399	30-07-2018
Saglek Deep/DFO3 (1000m)	30	60 27.887	61 6.794	1134	30-07-2018
DFO-750	31	60 27.666	61 13.164	716	31-07-2018
DFO-5 (1500m)	32	60 27.770	60 36.012	1429	01-08-2018
DFO (2000 m)	33	60 27.886	60 23.456	1887	02-08-2018
DFO8/Sponge1	34	60 28.081	59 15.130	2438	03-08-2018
Hatton Basin	37	60 26.167	60 40.212	604	05-08-2018
Lophelia site - rep1	40	60 22.126	48 27.808	753	06-08-2018
Lophelia site - rep2	40	60 22.126	48 27.808	753	06-08-2018

Latitude and longitude are bottom coordinates.

37.5 Conclusions

During the 2018 CCGS *Amundsen* expedition we accomplished nine ROV dives. While the first two dives were problematic, the CSSF's team aboard strategy of using the ROV inside the cage allowed us to collect good quality video data where sea state conditions permitted.

For each of the the different scientific objectives, ROV-related previously listed in section 2, we conclude that:

1. Assess biodiversity and depth distribution of corals, sponges, invertebrates and fish in deep-water areas of the northern Labrador Sea, including eDNA and pelagics. Pending data analyses.
2. Describe geomorphology of sites hosting the highest coral and sponge diversity, along the depth gradients.
   We have collected enough video data (ROV and DFO drop camera) that will allow us to fulfill these objectives.
3. Assess currents and seasonal variation in particulate organic matter composition in the largest coral and sponge hotspot of the NW Labrador Sea, at the northeastern edge of Saglek Bank. Pending data analyses. Not an ROV-target.
4. Assess seabird and marine mammal fauna within the proposed deep-water Marine Protected Area (MPA) off northern Labrador. Pending data analyses. Not an ROV-target.
5. Describe the depth distribution and biodiversity at the SW Greenland Lophelia pertusa scleractian coral locality, and the relationship to bottom geology and geomorphology. Enough video data collected at the Lophelia site will allow us to fulfill this objective.
6. Assess longevity and accretion rates of gorgonian and scleractinian coral habitats of the Labrador Sea and SE Baffin Bay. No gorgonian or scleractinian corals were collected.
7. Evaluate the strength of the West Greenland current over centennial to millennial timespans. Pending data analyses. Not an ROV-target.
8. Measure calcium carbonate saturation state and stable isotopic composition of dissolved nitrate and particulate organic matter in coral and sponge hotspots, to compare with the stable isotopes in coral calcite and protein layers for assessing paleoceanographic records in both calcareous and proteinaceous deep-sea corals. No long-lived corals were collected.
9. Analyze paleoceanographic records of primary production over centennial to millennial time-scales from gorgonian, antipatharian, and scleractinian coral skeletons. No long-lived corals were collected.
10. Assess the microbiology and associated oceanography of natural hydrocarbon seeps in Arctic waters. Pending data analyses.
11. Characterize the composition of natural and anthropogenic hydrocarbons found in Arctic waters, particularly in Frobisher Bay and near with the natural hydrocarbon seep at Scott Inlet. Pending data analyses by Dr. Casey Hubert's team. Sediment samples were successfully collected with the ROV, and water samples were collected using the Rosette.

37.6 Acknowledgement

We would like to thank the CCGS *Amundsen* captain Claude LaFrance, the ship crew, the scientific crew, the ROV operators Vincent Auger and Peter Lockhart (CSSF), and the chief scientist Dr. Philippe Archambault for the great work making this expedition possible.

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38 Vulnerable Marine Ecosystems of the Northern Labrador Sea and Baffin Bay: Biodiversity, Longevity, Paleoceanography, Microbiology and Conservation – Leg 2c

Project leaders: Evan Endinger[2](eedinger@mun.ca)
Cruise participants – Leg 2c: Philippe Archambault[1], Alec Aitken[3], David Côté[4], Vonda Wareham Hayes[4], Evan Edinger[2], Bodil Lauridsen[5], Andrew Murphy[4], Anirban Chakreborty[6], Julek Chawarski[2], Shaomin Chen[7], Barbarà de Moura Neves[4], Gustavo Guarin[1], Aprami Jaggi[6], Katarsyna Polcwiartek[8], Karl Purcell[9], Catie Young[2], Vincent Auger[10], Peter Lockhart[10], Barry Brake[10], Kandice Piccott[11], Meghan Dicker[12], Holly Hogan[13], Sabina Blackbird[14] and Graham Tulloch[14]
[1] *Université Laval, Québec, QC, Canada*
[2] *Memorial University of Newfoundland, St. John's, NL, Canada*
[3] *University of Saskatchewan, Saskatoon, SK, Canada*
[4] *Department of Fisheries and Oceans Canada, St. John's, NL, Canada*
[5] *Geological Survey of Denmark and Greenland, København, Danemark*
[6] *University of Calgary, Calgary, AB, Canada*
[7] *Dalhousie Univeristy, Halifax, NS, Canada*
[8] *University of Manitoba,Winnipeg, MB, Canada*
[9] *Université du Québec à Montréal, Montréal, QC, Canada*
[10] *Canadian Scientific Submersible Facility, North Saanich, BC, Canada*
[11] *Amundsen Science, Université Laval, Québec, QC, Canada*
[12] *Nunatsiavut Government, Nain, NL, Canada*
[13] *Environment and Climate Change Canada*
[14] *Atlas consortium, Liverpool, United-Kingdom*

38.1 Introduction

The goals of the NSERC-STAC funded program were focused on Vulnerable Marine Ecosystems in the northern Labrador Sea and southern Baffin Bay, especially their coral and sponge faunas and their oceanographic settings. Particular attention paid to (i) biodiversity along bathymetric gradients, (ii) surficial geology supporting VME habitats (iii), (iv) near-bottom currents and food delivery in gorgonian coral forests and sponge gardens of the NW Labrador Sea, and the (v) the paleoceanographic records that can be extracted from coral and sponge skeletons, and in sediments, including the stable C, N, O, Si, and H isotopes in the carbonate, silica, or organic portions of coral and spongeskeletons. Furthermore, we investigate calcium carbonate saturation in the waters of the region, and how saturation may affect the distribution of VME taxa. The major remaining goal of the NSERC-STAC funded program was to identify, film, and map hydrocarbon seeps and authigenic carbonates at the Scott Inlet hydrocarbon seep site in Baffin Bay, and to sample water and sediments at seep and seep-adjacent areas of the Scott trough.

The Super Mohawk (SuMo) ROV aboard CCGS *Amundsen* forms an integral part of the NSERC STAC, ArcticNet and DFO-funded programs. Associated research used instrumental data and water sampling from the CTD & rosette, planktonic invertebrate and ichthyoplankton sampling using the Hydrobios and monster nets, and benthic sampling using the box corer and Agassiz trawl. In addition, the DFO drop-video camera, which was built for this expedition, was used to characterize the seabed, megafauna and fish at several depths throughout the NW Labrador

Sea.. Seafloor mapping with multibeam sonar and sub-bottom profiler helped to characterize the geology of the seafloor underlying these benthic environments. Our integrated geological, biological, and oceanographic sampling program thus addresses these understudied environments in a holistic fashion.

Most sites were chosen based on previously identified coral and/or sponge diversity and abundance hotspots from scientific trawl survey bycatch data. These included the various sites around Hatton Basin, NE Saglek Bank, & SE Baffin Shelf. Exceptions were the site of extremely high coral bycatch in a commercial fishery trawl (NE Hatton Basin, outer), the bamboo coral forest at Disko Fan (Neves et al. 2015a), and the Scott Inlet hydrocarbon seeps. The bamboo coral forest at the Disko Fan (Neves et al. 2015) has been studied extensively in our 2013 and 2016 cruises, and an experiment was recovered from there during our 2017 cruise. Finally, an high profile scientific goal was to carry out detailed ROV investigations and sampling of the recently discovered Lophelia pertusa scleractinian coral occurrences in southwest Greenland (Kenchington et al. 2017).

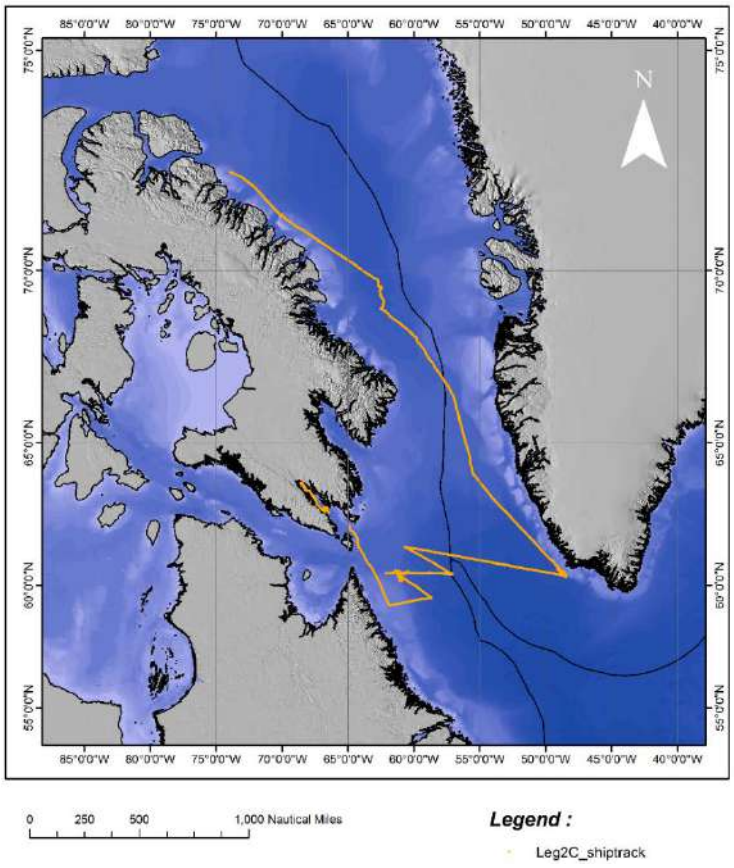

Figure 38-1 Cruise track. Scientific data collection began in Frobisher Bay on 25 July, and ended on 13 August 2018, at Scott Inlet, followed by a transit to Pond Inlet for refuelling, (14 August) and to Resolute Bay (not shown) for scientific and Coast Guard crew change (16 August). The airport at Pond Inlet is too small for a full Coast Guard and scientific crew change.

38.1.1 *Scientific Objectives*

1. Assess biodiversity and depth distribution of corals, sponges, invertebrates and fish in deepwater areas of the northern Labrador Sea, including plankton and mesopelagic fish.
2. Describe geomorphology of NW Labrador Sea sites hosting the highest coral and sponge diversity, along the depth gradients, and of the Lophelia pertusa occurrence in SW Greenland.
3. Assess currents and seasonal variation in particulate organic matter composition in the largest coral and sponge hotspot of the NW Labrador Sea, at the northeastern edge of Saglek Bank.
4. Assess seabird and marine mammal fauna within the proposed deep-water MPA off northern Labrador.
5. Describe the depth distribution and biodiversity at the SW Greenland Lophelia pertusa scleractinian coral locality, and the relationship to bottom geology and geomorphology.
6. Assess longevity and accretion rates of gorgonian and scleractinian coral habitats of the Labrador Sea and SE Baffin Bay.
7. Measure calcium carbonate saturation state and stable isotopic composition of dissolved nitrate and particulate organic matter in coral and sponge hotspots, to compare with the stable isotopes in coral calcite and protein layers for assessing paleoceanographic records in both calcareous and proteinaceous deep-sea corals.
8. Collect gorgonian, antipatharian, and scleractinian coral skeletons, from which to extract. paleoceanographic records of primary production over centennial to millennial time-scales.
9. Evaluate the strength of the West Greenland current over centennial to millennial timespans.
10. Assess the microbiology and associated oceanography of natural hydrocarbon seeps in Arctic waters.
11. Characterize the composition of natural and anthropogenic hydrocarbons found in Arctic waters, particularly in Frobisher Bay and near with the natural hydrocarbon seep at Scott Inlet.

38.1.2 *Scientific Objectives Accomplished*

Video transect collection with the ROV was generally successful, although in some cases, failure of the ROV required the use of the DFO drop-video camera to replace the ROV. Many of the sample collection objectives depended directly on the ROV, or on the ROV combined with the ROV elevator. Due to poor ROV performance, most ROV-based sampling objectives apart from video transects could not be met. In high-current settings, the ROV pilots evaluated the risk to the ROV from losing telemetry and video, and determined that attempting sample collection using the ROV would likely risk causing irreparable damage to the ROV. ROV-based sample collection of sediments and microbial mats from the hydrocarbon seeps at Scott Inlet was successful.

Other scientific tools were successfully deployed at all stations. The newly designed DFO dropvideo camera worked very well, as did almost all of the Amundsen standard scientific

equipment pool. The scientific sampling accomplished during the expedition, outside of Frobisher Bay, is described in Table 37.1.

Table 45-1 Summary of sites surveyed and sampled with the SuMo ROV and other tools during the 2018 CCGS *Amundsen* expedition, not including the Frobisher Bay sites. Numbers refer to the number of deployments of particularly sampling equipment in an area. Otherwise, X refers to extensive collection, while x refers to more limited collection. (NB: this table needs to be finished!)

Date	Site	Latitude (N)	Longitude (W)	Depth (m)	ROV Dive #	MBES	3.5 kHz	Drop video camera	CTD/ H_2O spl.	Plank-ton tow	Pelagic fish trawl	Box core	Agassiz trawl	Gravity core
25 July	Frobisher Bay				-	X	X	3	x			X	1	
26-July	Frobisher Bay				-	X	X	4	X			X	1	
27-July	Frobisher - steaming					X	x	1	x			x		
28-July	SE Saglek Bank	60.3807	-60.2805	550	A63	x	x	1	x	x	x	1	1	
29-July	NE Saglek Bank	60.4684	-61.2599	500	A64	X	X	2	x	x	x	-	-	
30-July	NE Saglek Deep	60.4692	-61.1056	1160		X	X	1	x	x	x	1	-	
31-July	NE Saglek Deep	60.4665	-61.1642	1000	A65	X	x	1	x	x	x	3	1	
01-Aug	NE Saglek 750 m	60.4337	-61.1976	750	A66	x	x	1		x	x	1		
02-Aug	NW Labrador Sea	60.4736	-60.6064	1424	--	X	x	1	x	x	x	1	-	
03-Aug	NW Labrador Sea	60.4665	-60.3750	1920	--	x	x	1	x	x	X	2	1	
	NW Labrador Sea	60.4686	-59.2632	2440				1	x	X	x			
04-Aug	NW Labrador Sea	60.4533	-57.0817	3000	--	x	x		x	x	X			
05-Aug	NE Hatton Sill	61.4396	-60.6634	620-550	A67	2006	X		1			-	-	
06-Aug	Steaming					X	X					-	-	
07-Aug	SW Grld. *Lophelia*	60.3664	-48.4572	950-700	A68	X	X		2	1		-	-	
08-Aug	SW Grld. *Lophelia*	60.3669	-48.4662	950-700	A69	X	X					x		
09-Aug	Steaming, water	63.2496	-54.2005	1175					2					
10-Aug	Disko Fan	67.9774	-59.4945	895		2013	2016		1			1		5
11-Aug	Steaming, water	68.9765	-62.4831	1892					1					
12-Aug	Scott Inlet	71.3783	-70.0737	260	A70-71	2013	2013		2					
13-Aug	Scott Inlet	71.4099	-69.9722	256	A72	2013	2013		12					

38.2 Methodology

38.2.1 *Assess biodiversity And depth distribution of corals, sponges, invertebrates and fish in deep water areas of the northern Labrador Sea, including plankton and mesopelagic fish.*

Corals and sponges: Corals and sponges have been documented in great abundance along the shelf break at 400-500m at the NE Saglek Bank area, both in the Northern Shrimp Survey trawl surveys (Kenchington et al. 2016), and in our 2016 ROV dive at NE Saglek Bank. In the Hatton Basin sill area, large gorgonian corals, especially Primnoa resedaeformis and, to a lesser extent, Paragorgia arborea, were common on boulders throughout the grounding line facies on the sill, identified from multibeam sonar in the region. Geodia and other astrophorid sponges were highly abundant in the 550 – 600 m depth range at the Hatton sill, and were observed forming dense spicule mats, and with sponges growing directly atop other sponges, similar to the morphology known as “ostur” (cheese-ground) in the NE Atlantic. Sponge diversity was reasonably high throughout NE Saglek ROV dives (A64, A66) and the Hatton Sill dive A67, but dense sponge mats were only observed at Hatton sill. Evidence of fishing damage was clear at NE Saglek bank around 700 m depth, with trawl marks visible in the ROV scanning sonar and in the ROV video, and overturned corals and sponges. Probable evidence of fishing damage to the Geodia sponge

mats at the Hatton Sill site was observed in the form of sharp linear edges to the sponge spicule mats.

With increasing depth in the NE Saglek Bank area, coral abundance appeared to decrease dramatically, although coral diversity remained somewhat high at the 750 m depth zone. By 1000 m, both coral diversity and abundance appeared to have decreased dramatically in the drop video camera footage. At depths below 1000 m, we had only the drop video data, rather than the comparison of drop---video and ROV video transects. The drop video surveys found corals and sponges at all depths down to the deepest depth surveyed, 2500 m, but the abundance and diversity of corals in the deeper areas appeared to be lower than at shallower depths. The drop video transect at 2500 m observed bamboo corals, probably Keratoisis sp., as well as soft corals and a variety of small sponges, not including Geodia. The box core at 2000 m recovered a small gorgonian coral, Acanthogorgia armata and the mushroom coral Anthomastus sp., probably A. grandiflorus (Figure 37.2).

Figure 38-2 2000m Box Core

This comparison will need to await quantitative analysis of the ROV video transects (A64, A66 at NE Saglek, in comparison with A52 from 2016; A67 at Hatton Sill), and the drop video transects at all depths. Because the drop---video camera transects were carried out in yo---yo mode with altitudes fluctuating between on---bottom and 5 m above bottom, rather than at a near---constant 1---2 m altitude of the ROV dives, the two types of video data will require careful parsing for analysis.

Other benthic invertebrate diversity. Other benthic invertebrates, both epifaunal and infaunal, were observed in drop video camera tows at all depths. One half of each box core was sieved and preserved for analysis of infauna. Estimates of fish abundance and diversity in ROV and drop video will have to await quantitative analysis.

Not surprisingly, plankton and mesopelagic fish abundance was highest at the shelf break, as documented in the EK60 fisheries sonar. Plantkon tows using the hydrobios multi---depth plankton sampler will allow quantitative comparisons of plankton between depths at the various

stations seaward along the shelf- abyss transect from the shelf break to 3000 m. Fish were most abundant and diverse at the Lophelia pertusa site. Fish composition varied with a depth along the NE Saglek shelf---slope transect, and was consistent with the longline and baited camera observations collected in 2017 (Coté et al. 2018, CSAS).

38.2.2 *Describe geomorphology of NW Labrador Sea sites hosting the highest coral and sponge diversity, along the depth gradients, and of the Lophelia pertusa occurrence in SW Greenland.*

Geomorphology was described using multibeam bathymetry, sub---bottom profiles, and ROV and/or drop camera to ground---truth acoustic data. Additional mapping was aimed mostly at the shelf break and upper continental slope, between (S extent position) and (N extent position), in the depth range of approximately 500 to 1300 m. The geomorphology of the coral and sponge rich sites at the NE edge of Saglek Bank is primarily a low to moderate slope sand and gravel plain with cobbles and boulders. This plain appears to be most likely derived as a glacial outwash plain, with channels, possibly proglacial outwash channels reminiscent of a braid plain, just landward of the areas surveyed. The boulders commonly host large gorgonian corals and large sponges including Geodia barretti. The sites with highest coral and sponge abundance are above the shelf break, in about 450 m water depth. The sites at 500 m and 750---700 m, which had lower coral and sponge abundance, were at the top of the rill and gully facies, but still showed very little bathymetric variation along the edge of the bank. By contrast, moving down to the 1000 m depth contour, the ridges of the rills in the rill and gully zone stand up to 100 m shallower than adjacent gullies. This rill and gully zone is apparent at both the NE Saglek Bank sites and the NE Hatton Basin (outer sill) locations. The tops of the rill ridges are mostly composed of sand, gravel, cobbles and boulders, with no evidence of exposed bedrock.

This geomorphology was radically different from the vertically exposed bedrock cliffs evident at the SW Greenland Lophelia site.

38.2.3 *Assess currents and seasonal variation in particulate organic matter composition in the largest coral and sponge hotspot of the NW Labrador Sea, at the northeastern edge of Saglek Bank.*

The HiBio2017A mooring deployed at approximately 500 m water depth in October 2017, with downward-looking ADCP, sediment trap, settlement plate, and hydrophone, was recovered at the end of July, 2018. Preliminary analysis of current measurements from the ADCP showed currents in the bottom 10 metres of the water column to be vigourous, with current speeds up to 30 cm/s. Dominant current direction was to the SE, but there was evidence for periodic changes in current direction that appear to be tidal. Furthermore, there was evidence for both upwelling and downwelling events at various times in the year, with upward or downward currents sometimes exceeding 50 cm/s. The data, and the current meter, will be returned to Memorial University for detailed analysis.

The sediment trap samples will be returned to Université Laval for analysis over the winter of 2018-2019.

The mooring was redeployed at approximately 1000 m depth, at (position). Unfortunately, the stainless steel mounting bracket for the current meter had suffered considerable corrosion at a critical point, and the mooring professional advised us against redeploying the current meter. Therefore the 1000 m mooring was redeployed with only the sediment trap and the INDEEP settlement plate.

A second mooring with the second downward-looking Aquadopp current meter, sediment trap, AMAR hydrophone, and INDEEP settlement plate was deployed at 1900 m, at (position). Interestingly, the box-core sample at 2000 m recovered two species of corals, including one gorgonian and one mushroom coral, and the drop-video camera transect at 2000 m recorded a variety of corals and sponges.

In addition to the two moorings, two benthic landers provided by the ATLAS consortium were deployed at two locations between 410 and 550 m. Each benthic lander is equipped with an ADCP, a sediment trap, a Doppler velocimeter The first lander was deployed at the southern end of the Hatton Basin coral and sponge fishery closure, at (position). This site was chosen for its relative lack of sponges, based upon standardized fishery stock assessment trawl surveys. The second lander was deployed at 410 m at the shallow end of an ROV transect recorded in 2016, where there were abundant corals and sponges. Although the original plan had been to survey this site with the ROV before the lander deployment, the lander professional was able to review the 2016 video and video analysis, in order to approve the location, based on its lack of boulders, and its abundance of corals and sponges.

38.2.4 *Assess seabird and marine mammal fauna within the proposed deep---water MPA off northern Labrador.*

Seabirds and marine mammals were assessed throughout the cruise leg by an on-board seabird and marine mammal observer, from Environment and Climate Change Canada. Observations were recorded in 1165 five-minute intervals (watches) while the ship was steaming between sampling stations. The observer intended made a maximum of 100 watches per day, limited by visibility (fog, darkness) and by the ship's sampling activities. The observer saw approximately 20 species of seabirds during the cruise, five species of cetaceans, three species of seals, and polar bears. Species at Risk observed within the NW Labrador Sea study area included Ivory Gull (Pagophila eburnea). Seabird and marine mammal observations will be returned to ECCC for mapping and quantitative analysis taking into account distance from the ship, time of day, visibility, sea state, ice conditions, and ship position, speed, and direction.

Seasonal marine mammal occupancy of the shelf-break environment at Saglek Bank was assessed using the AMAR hydrophone deployed on the HiBio2017A mooring in 500 m water depth, which was successfully recovered. The hydrophone will be returned to DFO –NL for analysis. Only one replacement hydrophone was available, and it was not possible to remove or

replace batteries in the recovered hydrophone while at sea. Therefore only one replacement hydrophone was deployed, at 1900 m.

38.2.5 *Describe the depth distribution and biodiversity at the SW Greenland Lophelia pertu sa scleractinian coral locality, and the relationship to bottom geology and geomorphology.*

Living Lophelia pertusa coral colonies were observed on steep and faulted igneous bedrock surfaces between 950 and 750 m water depth. Scleractinian coral rubble was common on ledges or crevices in the rock walls. Colony morphology ranged from globular to shelf---like and appeared to be largest and most abundant on walls facing into the prevailing and strong southeastern currents. Often Lophelia and large gorgonians dominate the SE---facing walls, and nephtheid soft corals dominate the SW--- and NW---facing walls. The associated invertebrate fauna was diverse and included e.g. brittle stars, star fish, squids, bivalves and squad lobsters. Many of the fish appeared to be unusually large either due to the high productivity at the site or the lack of human impact. The glacial deposits on the slope above the faulted bedrock are mostly gravelly sand, with cobbles and boulders hosting a different fauna than the rock walls. Parts of the sediment on the slopes above the bedrock wall appear slightly cemented perhaps due to authigenic carbonate crust.

38.2.6 *Assess longevity and accretion rates of gorgonian and scleractinian coral habitats of the Labrador Sea and SE Baffin Bay.*

Longevity and accretion rates of gorgonian coral habitats was to have been assessed using extensive collections of dead Primnoa coral skeletons from the Primnoa-dominated gorgonian coral forests at NE Saglek Bank and NE Hatton, and using gravity cores from the bamboo coral forest at Disko Fan. Inability of the ROV to collect samples prevented us from collecting dead coral skeletons at the northern Labrador Sea sites. Five gravity cores were collected from the Disko Fan bamboo coral site, spanning about 19 to 83 cm length. These gravity cores will supplement the records from 3 piston cores collected in 2016, which indicate a radiocarbon age of ~2638 ± 35 14C ybp for the earliest coral found immediately above the glacigenic gravels.

Of the five gravity cores and 2 push cores through a boxcore, collected in 2018, three of the gravity cores contained visible coral fragments near their edges, before applying x-ray imaging. It is unknown whether the box-core push cores contained coral fragments, but they were collected from a box core with abundant Keratoisis corals. Cores will be split and sub-sampled to extract coral samples for 14C dating at Dalhousie University. Cores will also be subsampled for microfossil analysis by the Geological Survey of Denmark and Greenland, including microfossil subsampling and analysis of our 2016 piston cores and trigger weight core.

Table 45-2 Gravity Cores collected at Disko Fan bamboo coral forest site

Core #	Lat	long	Water Depth (m)	Core length (cm)	observations
GC pt 2	67.9674	-59.49488	885	19	Mud above gravelly sand. Corals on core head gear, no coral fragments visible in core.
GC pt 3	67.97021	-59.49204	880	67	Mostly mud, gravelly sand at base. Dead coral fragments visible in core.
GC pt 4	67.97279	-59.50039	893	32	Cohesive mud. Coral fragments visible at 13 and 15 cm below surface
GC pt 5	67.97067	-59.49122	875	20	Mud at top, sandy gravel at base. No coral fragments visible.
GC pt 6	67.96958	-59.48938	874	83	Muddy at top, sandy below. Coral fragments visible at 30 cm depth
BC pt 6b	67.97023	-59.49178	882	60	Push core through box core with abundant Keratoisis corals (365 g corals in core).

38.2.7 *Measure calcium carbonate saturation state and stable isotopic composition of dissolved nitrate and particulate organic matter in coral and sponge hotspots, to compare with the stable isotopes in coral calcite and protein layers for assessing paleoceanographic records in both calcareous and proteinaceous deep-sea corals.*

In order to measure the isotopic composition of dissolved nitrate, and the potential influence of aragonite and calcite saturation state on VME distributions, water samples were collected at all benthic sampling stations, and at several intervening stations. Nutrient concentrations will be analyzed from frozen samples during Leg 3 of this year's Amundsen voyage (by the lab of J.E. Tremblay). Nitrogen isotope ratio of dissolved nitrate samples will be analyzed at Dalhouse University (O. Sherwood). Carbonate chemistry wasmples will be analyzed at the Bedford Institute of Oceanography (K. Azetsu-Scott).

38.2.8 *Collect gorgonian, antipatharian, and scleractinian coral skeletons, from which to extract paleoceanographic records of primary production over centennial to millennial time-scales.*

Unfortunately, due to ROV problems, we were unable to collect live or dead coral skeletons during this cruise. We will perform analyses on skeletons collected in previous years, or from fisheries stock assessment trawls and fisheries observers, using water samples as a guide to analysis.

38.2.9 *Evaluate the strength of the West Greenland current over centennial to millennial timespans*

In order to assess centennial to millennial changes in the strength of the West Greenland current, gravity cores from the Disko Fan site will also be subsampled for microfossil analysis by the Geological Survey of Denmark and Greenland. We will also subsample and analyze our 2016 piston cores and trigger weight core for microfossil analysis. There was no vertical accumulation of Lophelia skeletons to form a core-able reef at the SW Greenland Lophelia pertusa coral site. We considered attempting to core the thalweg of the canyon immediately below the Lophelia site, to look for coral rubble that might have been transported downslope into the canyon. Unfortunately, acoustic sub-bottom profiling using the 3.5 kHz did not reveal laminated sediments where we had intended to collect the gravity core. Therefore no cores were collected at the SW Greenland Lophelia site.

38.2.10 *Assess the microbiology and associated oceanography of natural hydrocarbon seeps in Arctic waters.*

Another objective was to investigate Arctic marine microbial diversity and biocatalytic potential of the Arctic marine microbiome in the context of an accidental spill of crude oil or shipping fuel in the Arctic. Regions of particular importance for understanding hydrocarbon biodegradation are seabed cold seeps where hydrocarbons are naturally present due to upward seepage from sources deeper in the seabed. ROV-guided intensive transect sampling in and around the seepage area was a top priority this year. A total of 28 hours of ship time was spent at Scott Inlet to conduct 3 ROV dives for video reconnaissance and sampling the seepage area followed by successive sampling at distances 1 and 5 km away from the seep epicentre. An active seep with gas bubbles ascending from 3 vents and white-greenish microbial mats at the surface was identified during the first hour of Dive 1. Seep materials were collected by scooping with ROV arms. Within this area (ca. diameter 100m) a number of other microbial mats were observed but most of them were not associated with actively emanating gas bubbles indicative of episodic or inactive seepage. The ROV-sampling was complemented by 12 CTD rosette deployments and bottom water sampling for microbiology following a four-directional transect keeping the seep area at the centre. A USBL beacon was fitted onto the rosette sampler to determine the exact bottom position relative to the seep location. Water samples were processed to preserve microbial biomass using different protocols for total cell counts, genomic and transcriptomic analyses.

38.2.11 *Characterize the composition of natural and anthropogenic hydrocarbons found in Arctic waters, particularly in Frobisher Bay and near with the natural hydrocarbon seep at Scott Inlet.*

This objective was focused on measuring baseline concentrations and composition of hydrocarbons in Arctic marine environment prior to future increase in marine traffic. Sediment sampling at Frobisher Bay and Disko Fan was conducted by collecting 30cm-long push cores from box cores. The push cores were subsequently sectioned at 1 cm intervals for the first 10

cm, and then 2 cm for the remainder of the core. Sectioned sediment was contained in aluminium foils, and stored at -20°C. Surface and bottom water samples were also collected from the same stations using CTD-rosette sampler. The water samples were processed onboard to extract the dissolved organic matter and the extracts were stored at 4°C for mass spectrometry analyses at the University of Calgary. At Scott Inlet, box coring was not possible due to the hard and rocky nature of the bottom; however seep materials and sediment samples were collected by the ROV. Water samples from multiple CTD-rosette deployments (cf: Objective #10) at this station were collected, processed and stored for further hydrocarbon geochemistry analyses at the University of Manitoba.

38.3 Incidents

38.3.1 *Time lost to weather*

We were very fortunate, and lost very little time to weather during this expedition. That said, we had to abandon two of the planned ROV dives, at the NE Hatton Basin 900 m site, and the SE Baffin Shelf 1000 m site, due to very high winds in the Northern Labrador Sea Aug 4-5, and we had to abandon two CTD/rosette stations (planned for measuring nutrients, carbonate chemistry, and methane) along the transect across the northern Labrador Sea, due to the same winds. By abandoning these stations, we arrived about 12 hours early at the SW Greenland Lophelia site, and dedicated this extra time to mapping submarine canyons in the region, and a drop-video camera survey on the shelf break above the Lophelia site. Similarly, we had to abandon one CTD/rosette station in Baffin Bay (planned for measuring nutrients, carbonate chemistry and methane) due to thick multi-year ice, which would have delayed our arrival in Scott Inlet.

We had to subtract an extra 12 hours form our planned route to allow for taking on additional fuel in Pond Inlet on August 14.

38.3.2 *SuMo ROV*

The biggest problem we encountered was the under-performance of the SuMo ROV. We knew that the SuMo was in its last year, and there would likely be a need for on-board repairs. Unfortunately, despite a retermination of the cable, the ROV was unable to collect samples in all any of the sites except Scott Inlet. In Scott Inlet, normal operation of the ROV outside its cage was possible because the umbilical cable was reterminated again, to < 500 m length, in order to remove any cable that had previously been spooled off the umbilical cable winch. Despite the inability to collect samples, the ROV was used effectively to collect video data, at nearly all of the targeted locations. In a few locations, we were able to substitute the new DFO drop-video camera (the “frankenbox”) in place of the ROV.

38.4 Preliminary Results

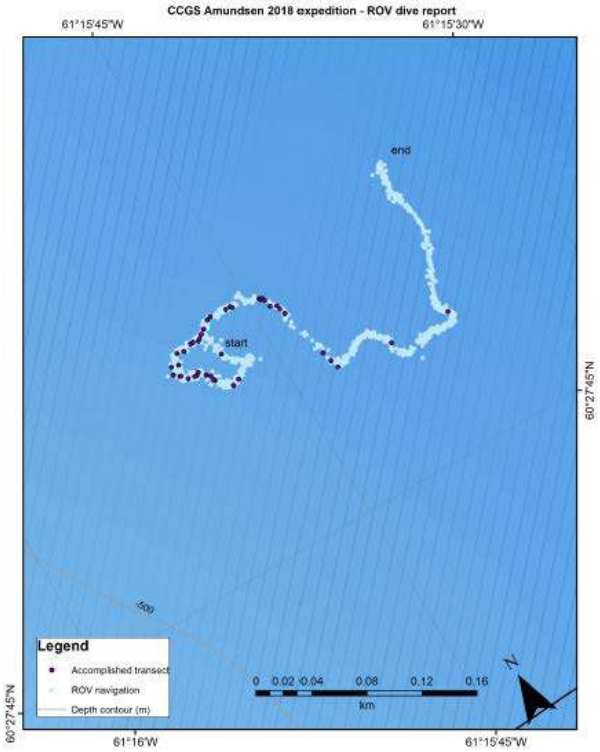

Figure 38-3 Map of dive A64 (NE Saglek Bank, 500 m) showing accomplished ROV transect during the 2018 CCGS *Amundsen* expedition.

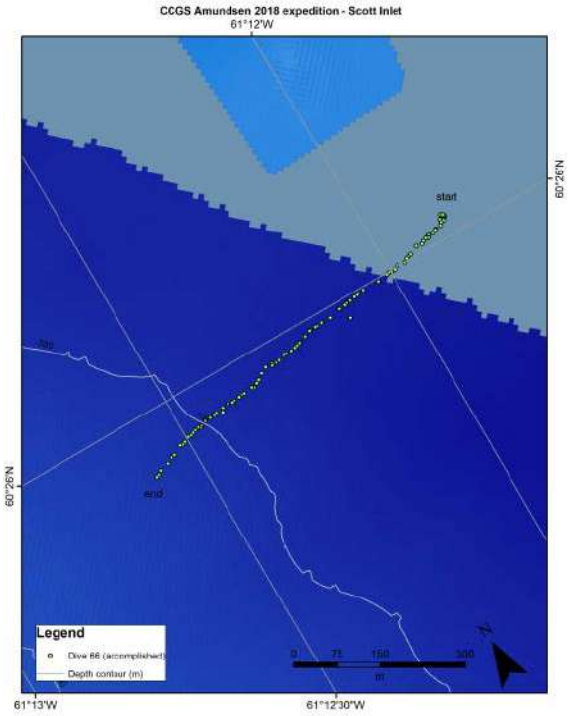

Figure 38-4 Map of ROV dive A66, NE Saglek Slope, 750-690 m

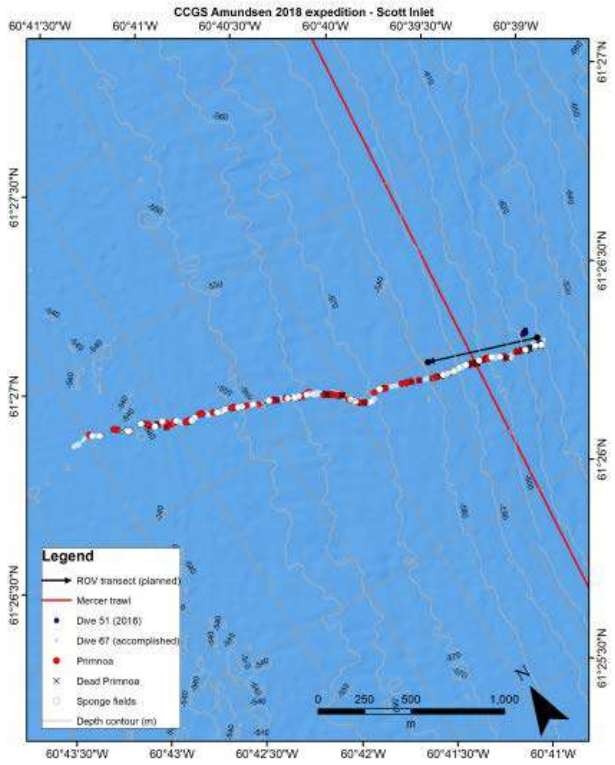

Figure 38-5 Map of dive A67, showing planned and accomplished transects. Contour interval 10 m

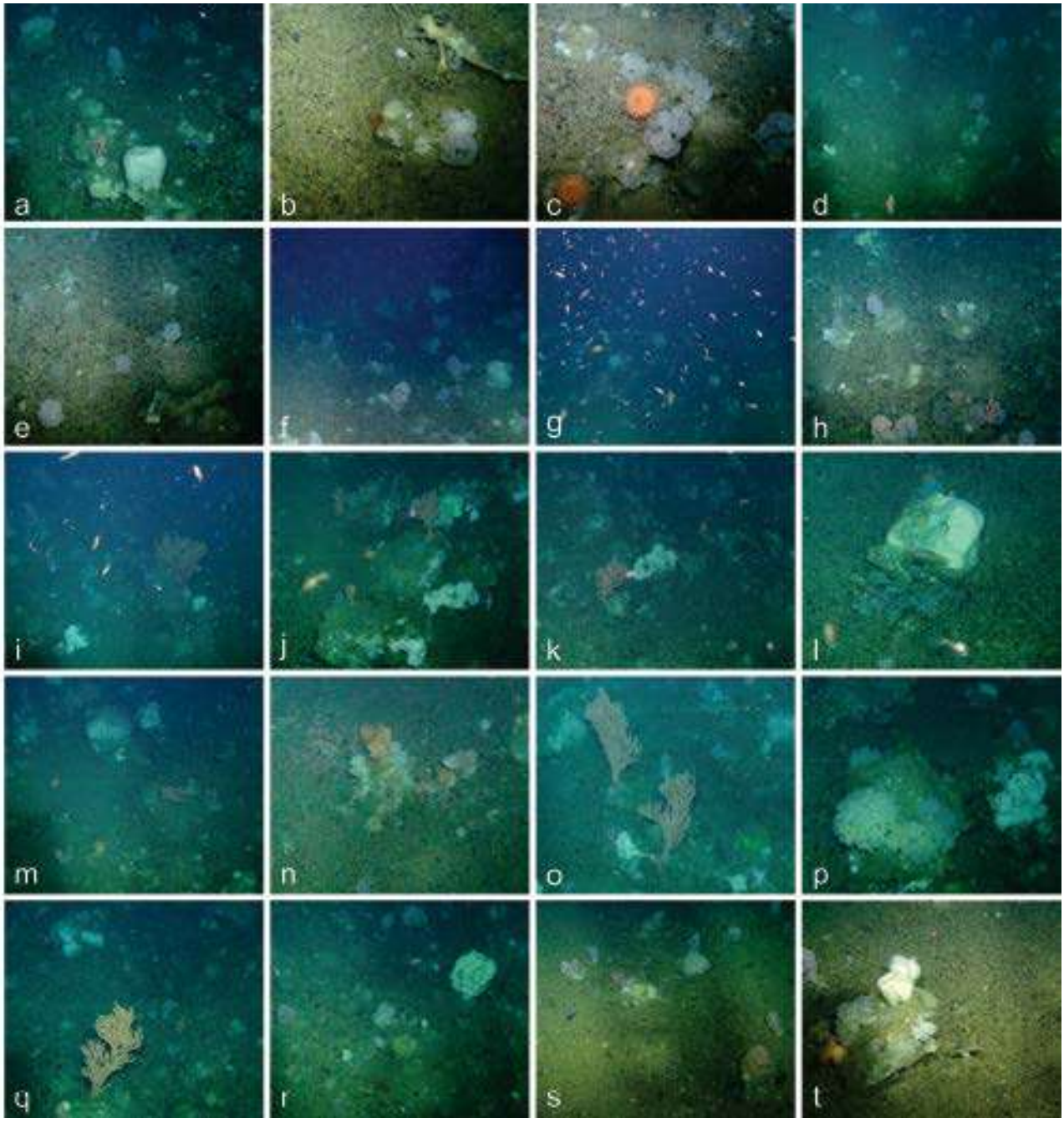

Figure 38-6 Photo-plate of megafauna observed during the ROV video transect of dive A64.
a. sponges and coral; b. sponges and soft corals with dead Primnoa; c. soft corals with sea anemones; d. soft corals; e. soft corals with dead gorgonian (bottom right); f. soft corals; g. water productivity h. soft corals and small Primnoa; i. soft corals and a large Primnoa resedaeformis; j-l. Small Primnoa resedaeformis on boulders with large overturned Geodia sponges; m-o. Overturned Primnoa with sponges p. Asconema and Geodia sponges; q. Primnoa resedaeformis and Geodia sponges; r-t. Sponges and soft corals

Figure 38-7 Photo-plate of megafauna observed during the Dive A66 ROV video transect at DFO-750-ridge. a. Halipteris sea pens and small Asconema glass sponge; b. Geodia barretti; c. small gorgonian corals (Para muricea) and sponges ; d and g. red mushroom corals (Anthomastus); e. damaged Paramuricea with Anthomastus mushroom corals; f. Anthoptilum sea pen and Anthomastus mushroom corals; h. cluster of juvenile Halipteris sea pens; i. Glass sponge Asconema and small Paramuricea gorgonian coral; j. Small sponges with juvenile skate; k. Sea pen (Halipteris), sponge and red mushroom coral (Anthomastus); l. Sebaste sp.m.small Paramuricea gorgonian corals; n. Sponges (Asconema sp. and ?Axinella) with Halipteris sea pen; o. sponges, sea pens and mushroom corals.

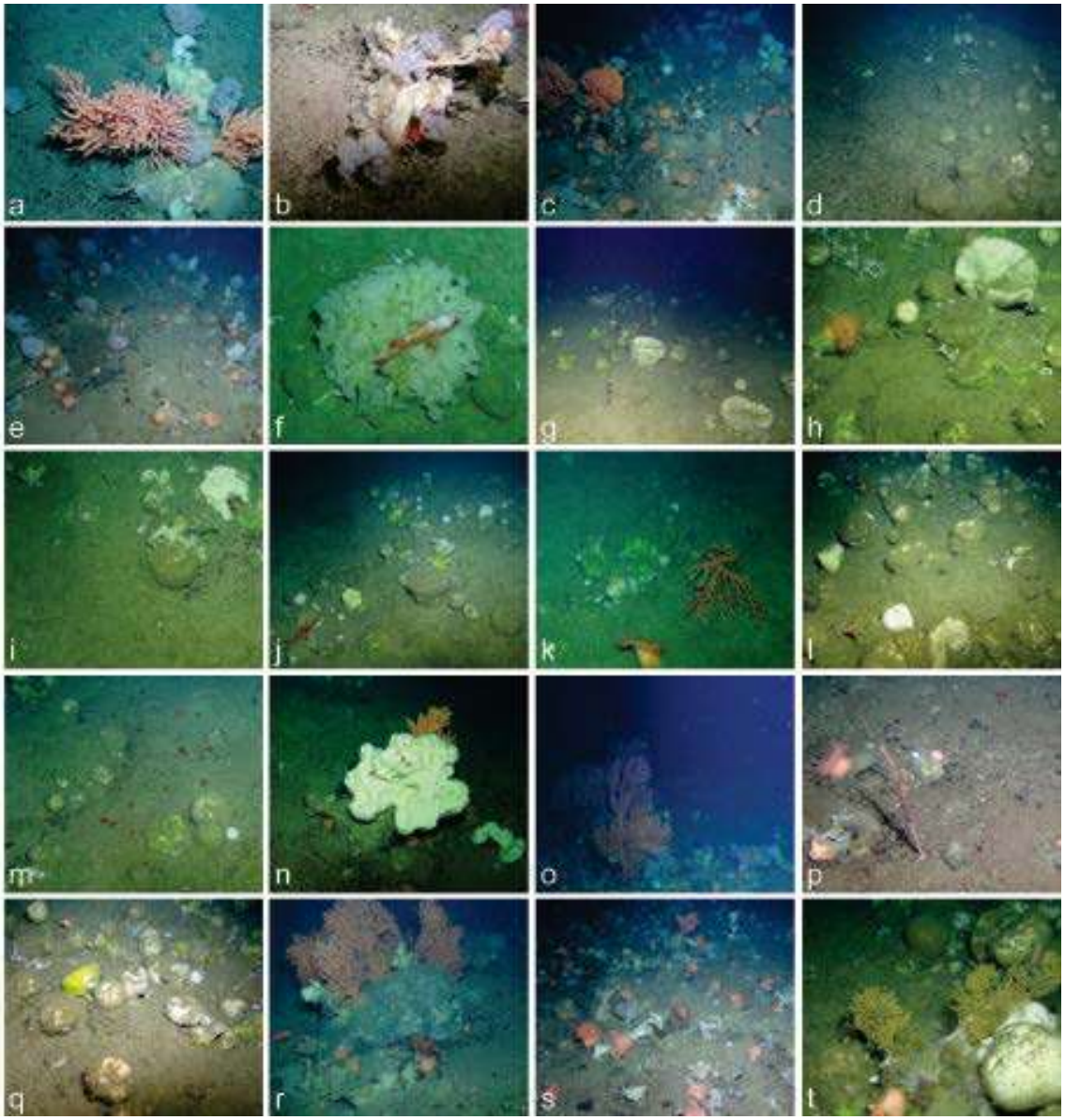

Figure 38-8 Photo-plate of megafauna observed during the ROV video transect at Hatton Sill (dive A67)
a. Primnoa, Duva florida, Mycale sp. on boulder; b. Dead Primnoa skeleton with sponges and Duva corals c. Primnoa resedaeformis, soft corals, sponges and sea anemones; d. Geodia sponge field (right) adjacent to ground impacted by fishing; e. Duva and sea anemones; f. Large Asconema glass sponge with Sebastes sp.; g-h. Geodia sponge fields including G. barretti, G. macandrewii, and epibiont Hexadella cf. dedritifera (yellow sponge); i. Geodia sponges and Radicipes sp.; j. Impacted (top left) sponge communities; k. Sponges next to recently impacted Paragorgia colony; l. Dense sponge grounds; m. Geodia sponges with red mushroom corals (Anthomastus); n. Large Geodia barretti (1 m in diameter) with Primnoa resedaeformis; o. Primnoa resedaeformis and Paragorgia arborea on boulders; p. Halipteris finmarchica sea pen with small juveniles (circled); q. Geodia sponge community. Note sponges growing on other sponges.; r. Sponges and Primnoa resedaeformis growing on top of boulders with dead skeletons at the base (bottom left); s. sponges and Primnoa resedaeformis with one Pennatula grandis sea pen (centre); t. Small Paramuricae colonies living among Geodia sponges.

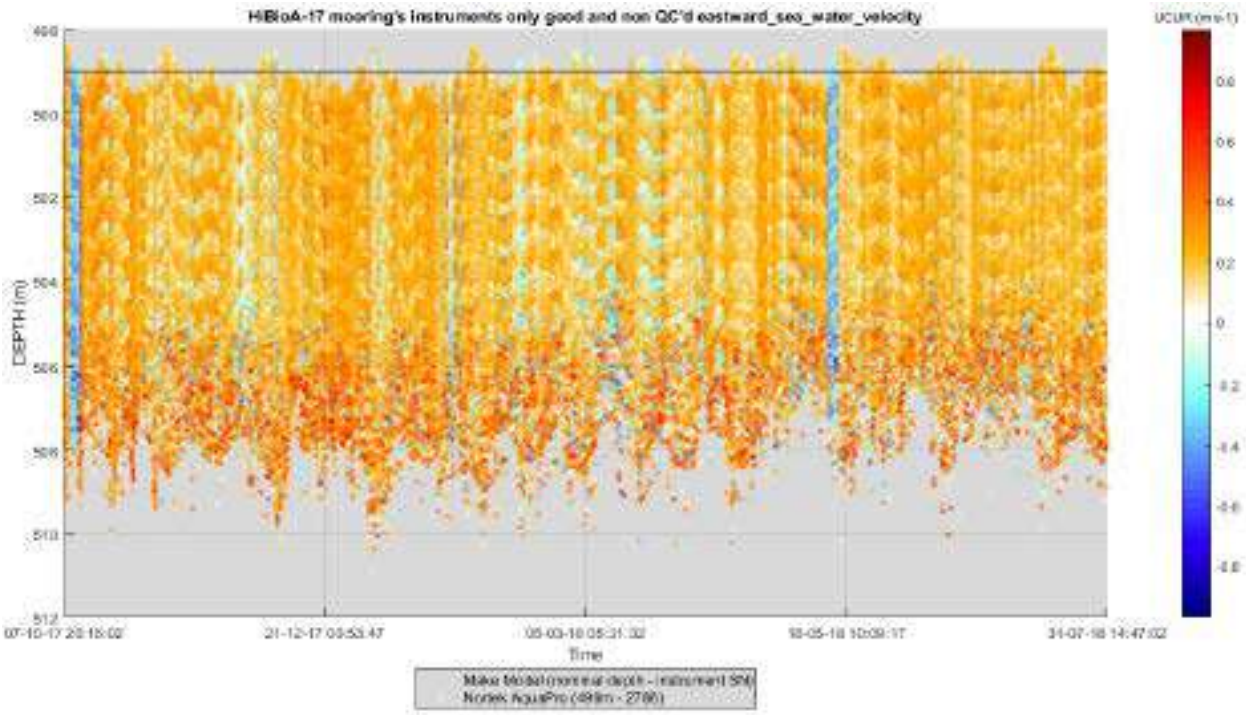

Figure 38-9 HiBioA-17 West - East Current profile 10m off bottom

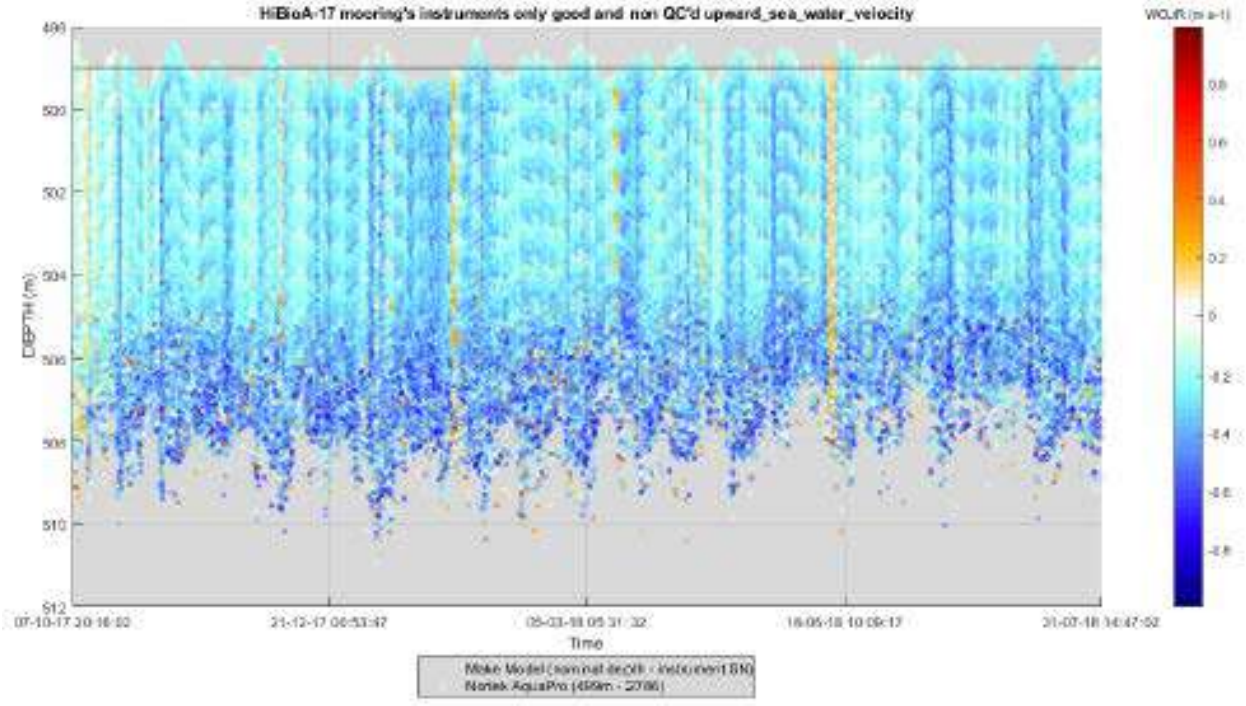

Figure 38-10 HiBioA-17 Up - Down Current profile 10m off bottom

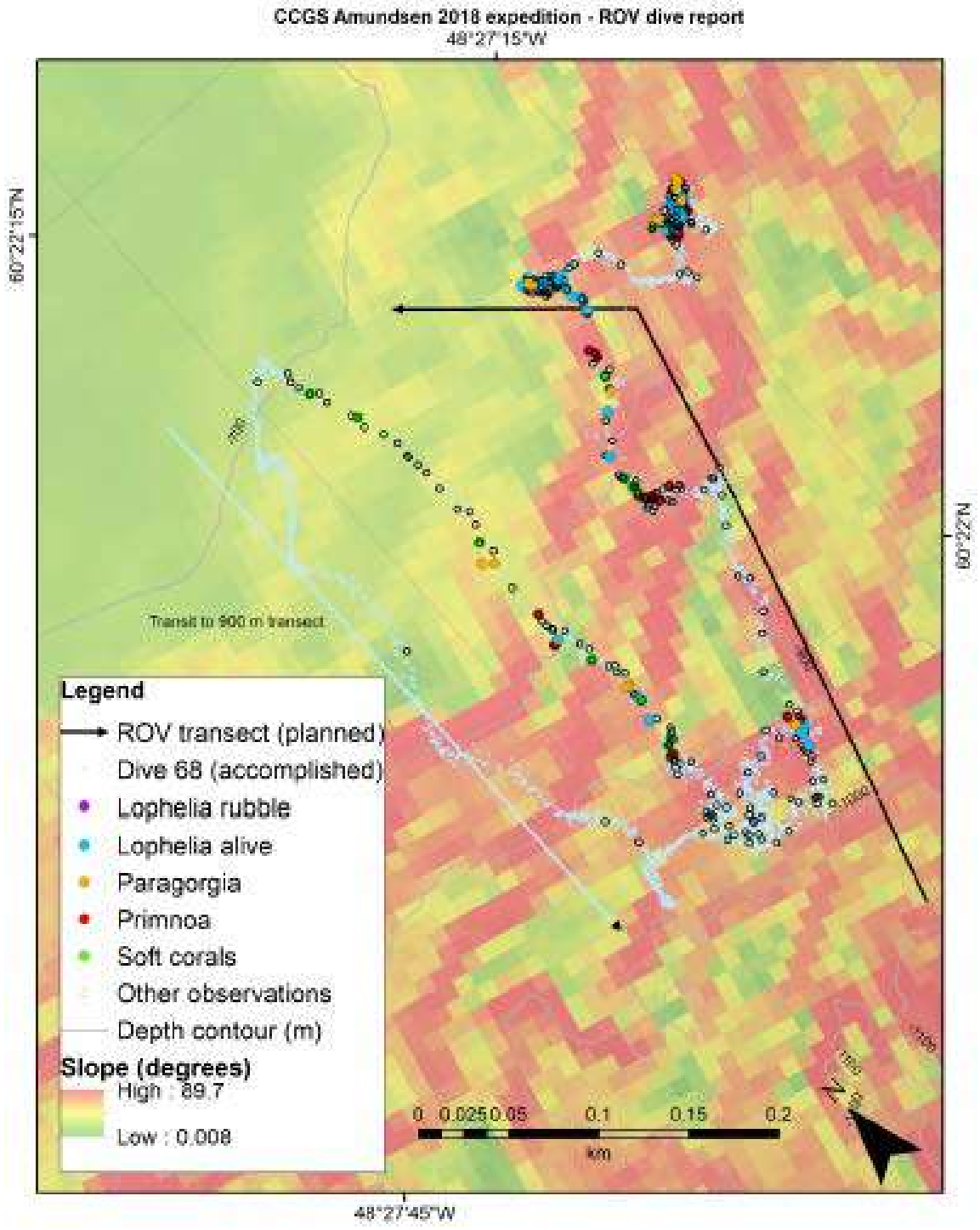

Figure 38-11 Map of dive 68, the first dive at the SW Greenland Lophelia site, showing the placement of the dive transects over the multibeam slope raster. Multibeam data from Boris Dorschel and Simon Dreutter, AWI, Germany.

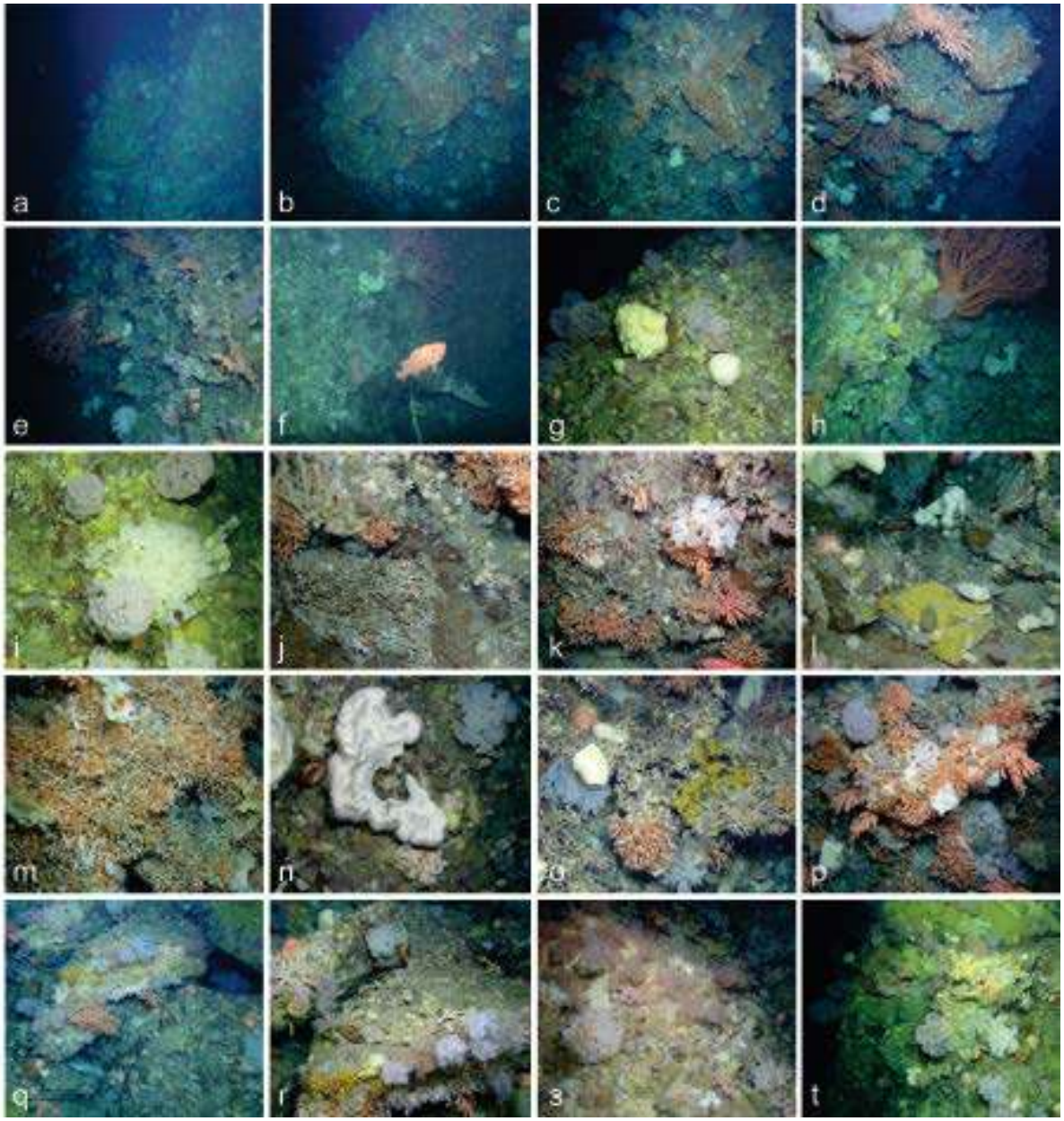

Figure 38-12 Photo plate, Lophelia dive 1.
a-d. Steep band angular edrock surface is covered with fauna including large gorgonian and colonial scleractinian corals and sponges. Note the loose block in figure a.; e. Large gorgonian corals and glass sponges – note they grow from crevices in the faulted blocks.; f. Large redfish (Sebastes norvegicus) exhibiting territorial behaviour, with large Paragorgia arborea in the background. g. Geodia sponges with large soft corals (?Duva); h. Large Paragorgia arborea (~1.5m) with Primnoa, soft corals and encrusting sponges. Note the joints in the bedrock.; i. White glass sponges and yellow encrusting sponges with large soft corals.;j. Lophelia colonies above ledge filled with dead fragments; k. Lophelia colonies with glass sponges and Acesta bivalves; l. Sponge fauna colonizing rock wall, ledge and loose boulders of bedrock; m. Lophelia colony with sponge associates; n. Wall encrusted with a large Geodia barretti sponge among other sponge species; o-p. Lophelia colonizing a over hang with colonial zoanthids (yellow), gorgonians, sponges and other fauna.; q. Rock wall fauna with wolffish (top right) and cusk (bottom left); r. Faulted bedrock with dead Lophelia rubble on the upper surface

and living sponges and corals on the lower surfaces; s. Soft corals with glass sponge (Asconema sp.?) and bamboo coral (centre); t. Rock wall fauna some growing in the crevices others on the more exposed surfaces.

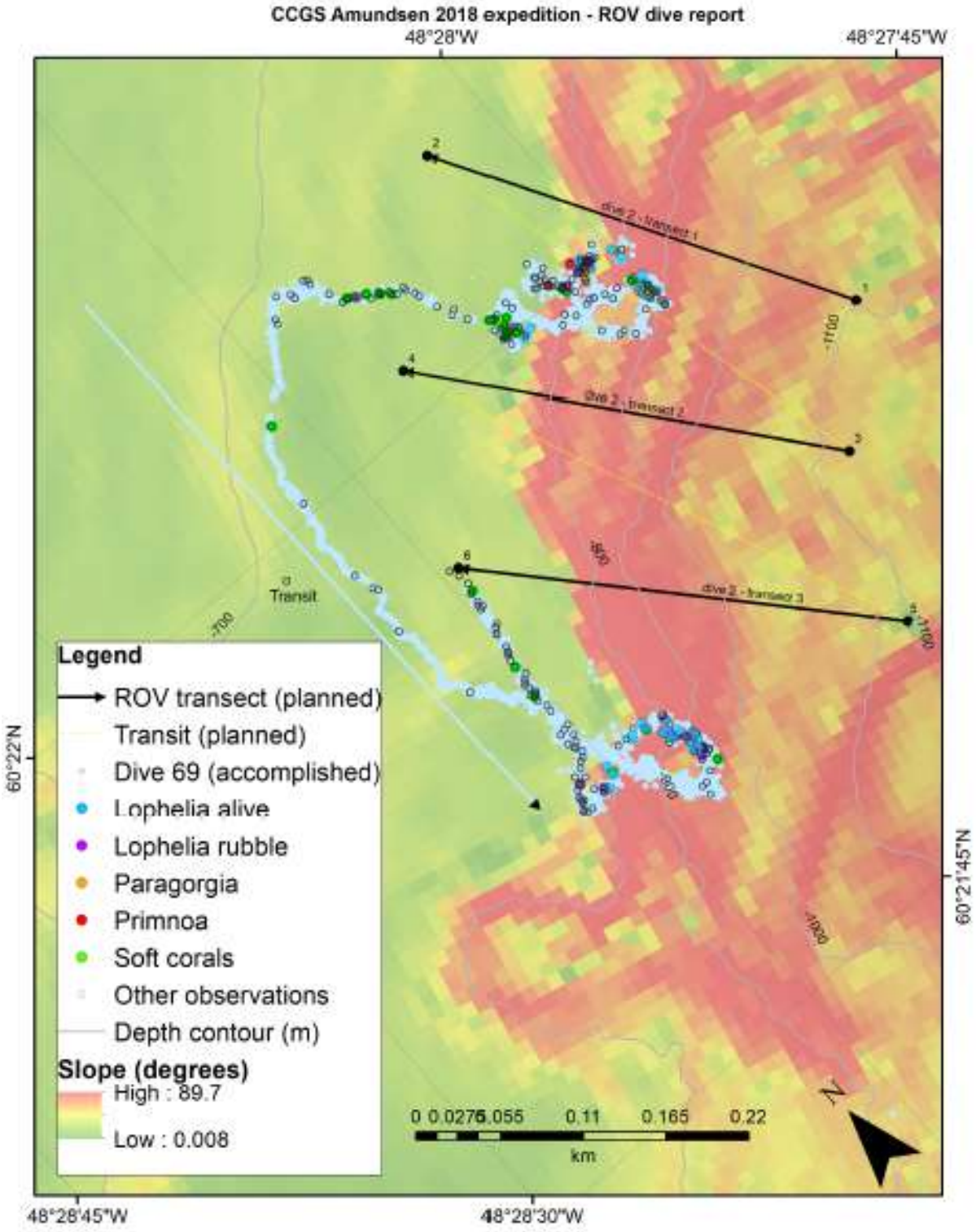

Figure 38-13 Map of dive A69 (Lophelia site, dive 2)

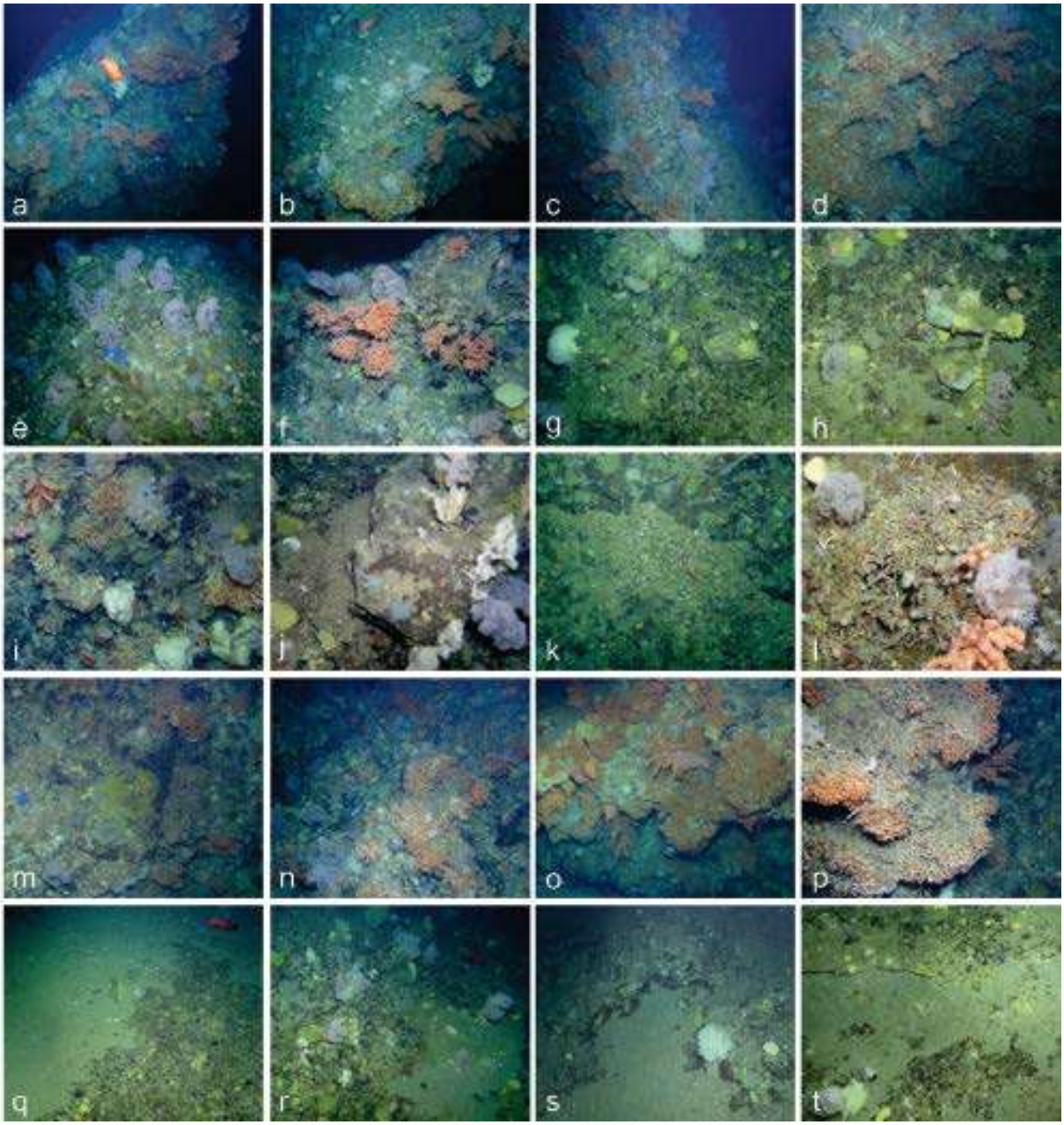

Figure 38-14 Photo-plate of megafauna observed during the ROV video transect at Lophelia site 2.
a–c. Two aspects of the rock wall pinnacle with different fauna on each side - soft corals on the left side and gorgonians and Lophelia on the right. Note the small cephalopod swimming in front of the ROV camera (a) and redfish (b). d. Lophelia colonies on overhung bedrock.; g–h. Poorly sorted sand and subangular gravel on sloping shelf break above bedrock cliffs.; i. Sponges and soft corals growing on a loose block; k. Lophelia coral rubble on the foot of the rock wall; m Lophelia coral rubble on ledges and crevices in the bedrock; q–t. Erosional scars in the glacial deposits on the slope, cutting into the slightly cemented crust, possibly authigenic carbonates.

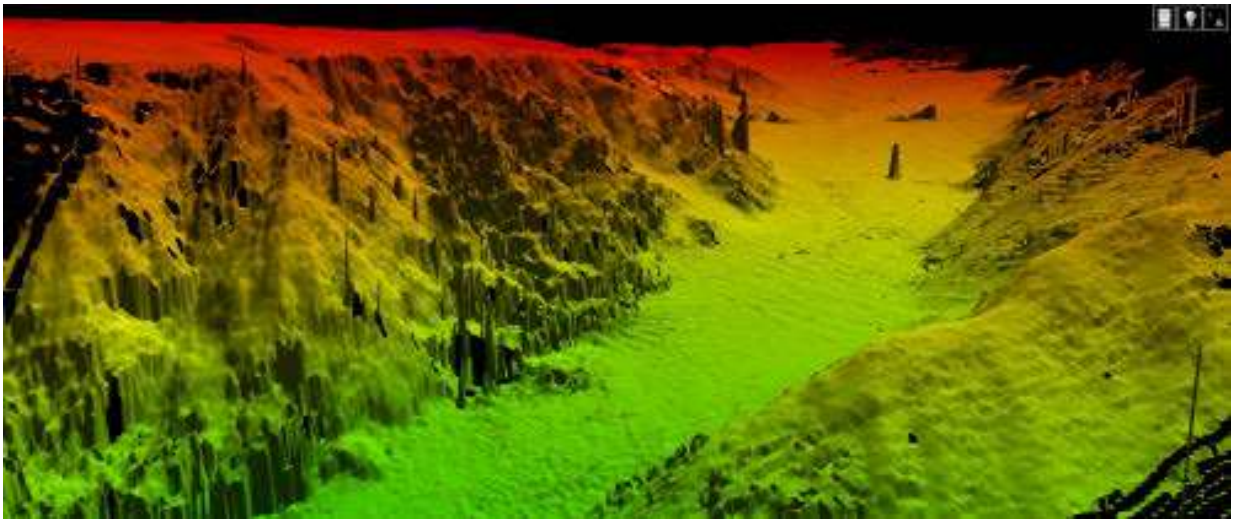

Figure 38-15 3D-bathymetric model of bathymetry near Lophelia sites 1 and 2.
The vertical exaggeration on this image is 1 (no vertical exaggeration). The Lophelia occurrences are on the steep bedrock walls in centre-left. The shallowest water shown at the top of the shelf –break is approximately 600 m, while the deepest water shown in the thalweg of the canyon is about 1700 m. The large canyon to the south of the Lophelia site was considered as a gravity coring target to look for evidence of Lophelia rubble in sediments, but sub-bottom profiling did not yield convincing evidence of a soft bottom, so the gravity coring operation was cancelled. Image by Luca Arduini-Plaisant, Amundsen Science hydrographic intern.

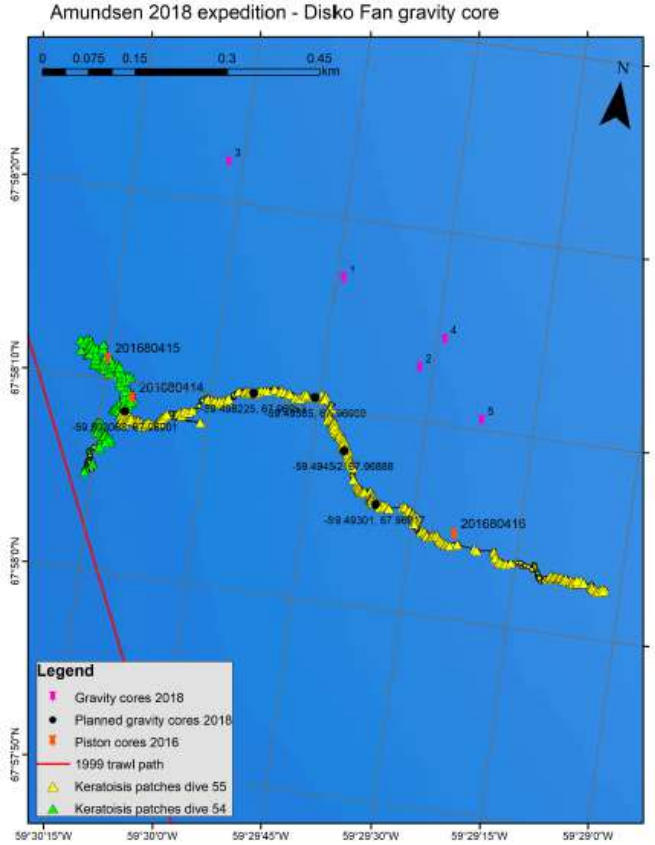

Figure 38-16 Map of Disko Fan gravity cores in relation to Keratoisis coral percent cover as observed in 2016 ROV video transect.

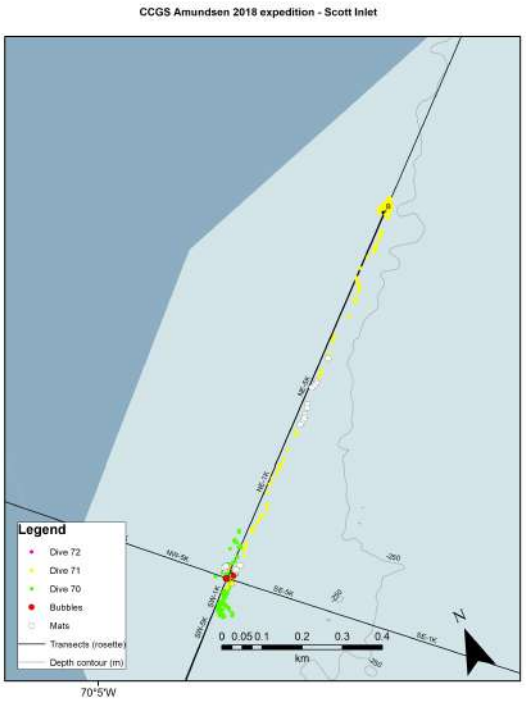

Figure 38-17 Map of ROV dive transects A70 and A71, showing locations of (?)methane bubbles and microbial mats.

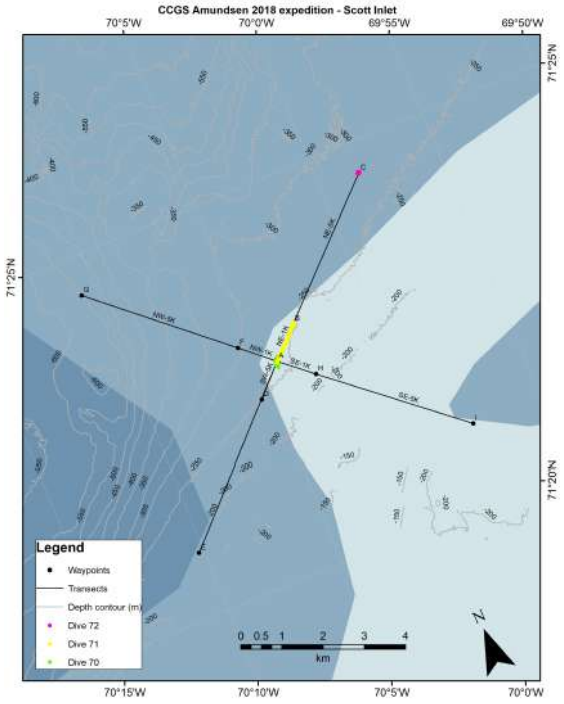

Figure 38-18 Map of Dives A70-A72 in Scott Inlet

Figure 38-19 Photo plate from Dive A70, methane seeps and microbial mats, Scott Inlet

Table 45-3 Information on CTD-rosette sampling at ROV and other sites during the 2018 Amundsen expedition

Station ID	Date	Latitude	Longitude	Depth (m)	pCO_2/CH_4	DIC/TA	Nutrients	NO_3 isotope
9b	26/07/2018	62.67712	-66.48839	485.33	x	x	x	
Sponge Site 5	27/07/2018	60.40044	-62.90011	300.96			x	
Non-sponge Site 5	28	59.22465	-61.82626	150.68			x	
Non-sponge Site 4	28	59.31119	-61.01718	205.54			x	
Non-sponge Site 2	28	59.47487	-59.44245	1961			x	
Non-sponge Site 1	29	59.53374	-58.63407	2378.36			x	
Saglek Bank	29	60.45298	-61.25635	516.57	x	x	x	x
Sponge Site 4	30	60.45967	-62.12046	368			x	
Saglek Deep	31	60.4663	-61.10411	1138.11	x	x		
Sponge Site 2	02	60.46692	-60.38003	1940.02			x	
Sponge Site 1	03	60.46845	-59.25748	2415.08			x	
DFO-9	03	60.47102	-58.81319	2489.32	x	x	x	
DFO-11	04	60.44128	-57.09002	3026			x	
Hatton Basin	05	61.43727	-60.66732	612	x	x		
Lophelia	06	60.36968	-48.46247	700	x	x	x	x
NLSE07	09	63.2509	-54.1989	1175.29	x	x	x	x
SW Greenland-1	09	63.99804	-55.50314	1078.23			x	x
SW Greenland-2	10	66.49895	-57.00849	667.45			x	x
Disko Fan	10	67.97867	-59.51255	910.6	x	x	x	x
SW Greenland-3	11	68.97749	-62.48307	1892	x	x	x	x
Scott Inlet	12			~240	x	x	x	x

38.5 References

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Leg	Station ID	Station Type	UTC Date	UTC Time	Latitude (N)	Longitude (W)
Leg 1						
1	354	Nutrient	31-05-18	23:02:14	60° 58,051'	64° 48,388'
1	356	Nutrient	31-05-18	19:20:02	60° 48,172'	64° 36,886'
1	HN01A	Nutrient	01-06-18	16:44:05	62° 01,690'	69° 33,050'
1	352	Nutrient	01-06-18	01:56:44	61° 09,325'	64° 55,405'
1	FB01	Nutrient	02-06-18	23:03:03	64° 16,416'	78° 12,150'
1	FB03	Basic	03-06-18	21:24:25	63° 44,094'	79° 56,291'
1	FB02	Nutrient	03-06-18	06:34:56	64° 03,704'	79° 03,716'
1	FB01A	Nutrient	03-06-18	01:58:11	64° 12,621'	78° 35,301'
1	BS# 11	Basic	04-06-18	22:45:10	62° 52,298'	78° 53,628'
1	BS# 10	Basic	04-06-18	07:11:06	63° 26,686'	79° 26,449'
1	BS# 15	Basic	05-06-18	22:39:17	63° 08,618'	81° 47,942'
1	BS# 14	Nutrient	05-06-18	11:46:43	63° 11,781'	81° 51,123'
1	BS# 13	Nutrient	05-06-18	10:35:04	63° 15,696'	81° 39,960'
1	BS# 12	Nutrient	05-06-18	08:13:05	63° 23,794'	81° 13,746'
1	BS# 16	Ice	06-06-18	23:56:57	62° 18,719'	85° 51,403'
1	BS# 18	Full	08-06-18	23:40:02	63° 24,205'	89° 25,693'
1	BS# 17	Basic	08-06-18	00:48:24	63° 11,194'	90° 01,626'
1	BS# 19	Basic	09-06-18	20:49:37	61° 50,673'	92° 10,216'
1	BS# 21	Full	10-06-18	22:48:39	60° 55,385'	89° 22,785'
1	BS# 20	Nutrient	10-06-18	03:01:06	61° 22,730'	90° 56,572'
1	BS# 22	Full	11-06-18	20:30:19	60° 25,666'	94° 01,202'
1	BS# 23	Nutrient	12-06-18	04:13:13	60° 55,615'	91° 48,131'
1	BS# 25	Full	13-06-18	18:52:20	62° 00,982'	87° 00,998'
1	BS# 24	Ice	13-06-18	00:08:45	61° 42,304'	87° 47,077'
1	BS# 27	Nutrient	14-06-18	12:30:25	62° 34,888'	90° 55,379'
1	BS# 26	Nutrient	14-06-18	02:24:17	62° 12,051'	88° 22,636'
1	BS# 28	Nutrient	15-06-18	04:52:50	62° 25,933'	89° 49,119'
1	BS# 29	Full	16-06-18	13:44:12	61° 46,047'	84° 17,875'
1	BS# 31	Nutrient	18-06-18	18:39:22	57° 30,020'	91° 48,031'
1	BS# 32	Ice	19-06-18	21:33:42	56° 57,130'	88° 07,064'
1	BS# 33	Ice	20-06-18	14:29:44	56° 36,071'	87° 03,917'
1	BS# 34	Full	21-06-18	18:37:17	56° 34,981'	86° 44,438'
1	BS# 36	Basic	22-06-18	20:21:17	57° 46,542'	86° 01,681'
1	BS# 35	Nutrient	22-06-18	03:08:47	57° 10,757'	86° 29,880'
1	BS# 38	Basic	23-06-18	23:25:12	58° 43,387'	86° 17,733'
1	BS# 37	Nutrient	23-06-18	03:51:35	58° 28,272'	86° 13,453'
1	BS# 40	Basic	24-06-18	19:55:27	58° 14,875'	88° 35,838'
1	BS# 39	Nutrient	24-06-18	07:03:14	58° 28,785'	87° 26,404'
1	NE03	Mooring	25-06-18	17:59:00	57° 30,265'	91° 47,865'
1	BS# 41	Nutrient	25-06-18	04:40:00	58° 01,363'	89° 46,840'
1	CM 03	Basic	27-06-18	15:07:00	63° 11,384'	81° 53,786'
1	BS# 44	Basic	28-06-18	20:45:00	59° 59,312'	91° 57,331'
1	CMO01	Basic	28-06-18	15:05:00	59° 58,610'	91° 56,422'
1	Nelson River	River	30-06-18	21:50:00	57° 18,198'	92° 01,717'
1	BS# 46	Full	01-07-18	21:54:00	57° 30,252'	91° 48,060'
Leg 2a						
2a	730	Nutrient	08-07-18	19:45:36	56° 11,231'	76° 43,125'
2a	731	Nutrient	08-07-18	13:40:19	55° 24,523'	77° 55,002'
2a	736	Basic	09-07-18	12:51:23	58° 25,947'	78° 19,222'
2a	431	Basic	12-07-18	18:41:23	61° 57,105'	70° 45,379'
2a	689	Basic	12-07-18	02:24:18	62° 20,905'	75° 32,221'
Leg 2b						
2b	1	Basic	16-07-18	17:08:54	68° 17,212'	60° 29,396'
2b	2	Ice	17-07-18	19:45:39	67° 57,820'	61° 33,960'

2b	Float deployment	Argo	17-07-18	03:14:19	69° 17,508'	60° 42,616'
2b	3	Basic	18-07-18	20:05:53	67° 47,367'	62° 20,825'
2b	5	Basic	19-07-18	19:30:32	67° 28,484'	63° 49,395'
2b	4	Ice	21-07-18	21:09:09	67° 32,934'	63° 35,154'
2b	6	Basic	22-07-18	14:20:13	67° 14,293'	64° 37,606'
2b	7	Basic	23-07-18	16:37:49	64° 39,608'	59° 47,032'
Leg 2c						
2c	Outer Bay A	Nutrient	25-07-18	22:38:31	63° 06,562'	67° 26,170'
2c	11c	Basic	25-07-18	19:55:43	63° 09,970'	67° 33,114'
2c	Microplastics Trawl-1	Nutrient	25-07-18	11:16:55	63° 38,796'	68° 32,084'
2c	BELL-10	Coring	25-07-18	06:47:54	63° 35,663'	68° 20,072'
2c	BELL-09	Coring	25-07-18	06:10:19	63° 32,236'	68° 22,854'
2c	4a	Basic	26-07-18	18:09:19	62° 47,056'	66° 51,415'
2c	7b	Basic	26-07-18	16:43:39	62° 44,014'	66° 34,402'
2c	20D	Basic	26-07-18	15:06:20	62° 50,977'	66° 35,013'
2c	13c	Basic	26-07-18	11:42:16	62° 42,305'	66° 44,888'
2c	2A	Basic	26-07-18	04:39:55	62° 58,928'	67° 22,249'
2c	12C	Basic	26-07-18	01:37:55	63° 04,849'	67° 25,453'
2c	Sponge site 5	Nutrient	27-07-18	20:24:11	60° 24,097'	62° 53,979'
2c	15C	Basic	27-07-18	05:55:32	60° 24,097'	62° 53,979'
2c	10B	Basic	27-07-18	01:17:08	62° 39,331'	66° 23,878'
2c	9B	Basic	27-07-18	00:05:52	62° 40,401'	66° 29,280'
2c	Non-Sponge Site 3	ROV	28-07-18	19:52:39	59° 22,897'	60° 16,729'
2c	Non-Sponge Site 4	Nutrient	28-07-18	06:51:26	59° 18,483'	61° 00,380'
2c	Non-Sponge Site 5	Nutrient	28-07-18	03:41:54	59° 13,513'	61° 49,535'
2c	Saglek bank (DFO1)	ROV	29-07-18	20:38:51	60° 27,969'	61° 15,628'
2c	Non-Sponge Site 1	Nutrient	29-07-18	06:39:26	59° 32,069'	58° 38,881'
2c	Non-Sponge Site 2	Nutrient	29-07-18	01:09:15	59° 28,650'	59° 27,490'
2c	Sponge Site 3	ROV	30-07-18	15:58:05	60° 28,026'	61° 18,090'
2c	Sponge site 4	Nutrient	30-07-18	08:11:18	60° 27,428'	62° 05,860'
2c	DFO-1	Full	30-07-18	02:05:23	60° 27,656'	61° 15,999'
2c	HiBio-A-2017	Mooring	31-07-18	15:10:32	60° 27,501'	61° 15,750'
2c	Saglek Deep (DFO-3)	ROV	31-07-18	13:50:31	60° 27,977'	61° 09,852'
2c	DFO-750	ROV	01-08-18	22:16:58	60° 25,777'	61° 12,627'
2c	DFO-3	Mooring	01-08-18	17:21:33	60° 27,843'	61° 09,544'
2c	18-DFO-RIDGE	Other	01-08-18	15:41:33	60° 27,178'	61° 07,685'
2c	Hibio-B 2018 (DFO-7)	Mooring	02-08-18	13:55:17	60° 28,419'	60° 22,515'
2c	DFO-5	Full	02-08-18	11:14:16	60° 27,934'	60° 34,691'
2c	DFO-8	Full	03-08-18	18:21:14	60° 28,106'	59° 14,697'
2c	(DFO-7) Sponge site 2	Nutrient	03-08-18	01:53:31	60° 28,563'	60° 22,507'
2c	DFO-11	Full	04-08-18	16:16:27	60° 26,594'	57° 04,839'
2c	DFO-9	Full	04-08-18	05:50:27	60° 28,675'	58° 48,609'
2c	Hatton Bassin	ROV	05-08-18	15:11:16	61° 26,705'	60° 42,742'
2c	Lophelia	ROV	08-08-18	16:39:00	60° 22,208'	48° 27,431'
2c	SW Greenland-1	Nutrient	09-08-18	22:52:28	63° 59,777'	55° 30,886'
2c	NLSE07	Nutrient	09-08-18	16:37:37	63° 14,968'	54° 11,831'
2c	SW Greenland-2	Nutrient	10-08-18	12:37:48	66° 29,971'	57° 01,847'
2c	SW Greenland-3	Nutrient	11-08-18	15:56:29	68° 59,191'	62° 29,172'
2c	Disko Fan	Basic	11-08-18	05:07:14	67° 58,348'	59° 30,183'
2c	SW-5K E	CTD	12-08-18	23:48:57	71° 20,853'	70° 10,544'
2c	0 time1 A1	CTD	12-08-18	22:54:52	71° 22,557'	70° 04,308'
2c	Scott Inlet	ROV	12-08-18	20:31:13	71° 22,703'	70° 04,388'
2c	0 time4 A4	CTD	13-08-18	13:58:59	71° 22,618'	70° 04,617'
2c	NE-5K C	CTD	13-08-18	12:55:31	71° 24,555'	69° 58,435'
2c	SE-1K H	CTD	13-08-18	09:48:44	71° 22,289'	70° 02,862'
2c	SE-5K I	CTD	13-08-18	07:43:26	71° 20,992'	69° 57,585'
2c	(0 time 3) A3	CTD	13-08-18	06:45:30	71° 22,706'	70° 04,133'
2c	Nw-1k-f	CTD	13-08-18	05:50:03	71° 23,087'	70° 05,381'

2c	Nw-5k-g	Other	13-08-18	04:36:13	71° 24,507'	70° 10,657'
2c	(0 time 2) A2	CTD	13-08-18	03:05:24	71° 22,708'	70° 04,122'
2c	(SW-1K) D	Other	13-08-18	01:55:00	71° 22,412'	70° 04,036'
Leg 3						
3	River in Lefeuvre	River	18-08-18	16:02:24	72° 03,116'	96° 01,081'
3	312	Basic	19-08-18	16:46:46	69° 10,705'	100° 41,607'
3	QMG2	Basic	21-08-18	12:05:36	68° 18,590'	100° 47,427'
3	QMG1	Basic	21-08-18	07:52:43	68° 28,975'	99° 52,272'
3	QMGM	Basic	22-08-18	17:52:38	68° 18,192'	101° 44,568'
3	wf1	Mooring	22-08-18	13:59:15	68° 14,301'	101° 48,060'
3	QMG3	Basic	22-08-18	10:49:52	68° 19,400'	102° 55,392'
3	QMG4	Basic	22-08-18	06:53:41	68° 28,660'	103° 24,891'
3	site 1.1 (Manson)	Coring	27-08-18	19:41:34	76° 28,876'	78° 43,844'
3	322	CTD	27-08-18	04:58:08	74° 29,649'	80° 38,686'
3	106	lander	28-08-18	23:16:20	76° 18,472'	75° 21,473'
3	Near trinity	CTD	28-08-18	12:16:50	77° 27,721'	75° 54,316'
3	101	Basic	28-08-18	03:48:39	76° 23,530'	77° 24,202'
3	Argo buoy	Argo	29-08-18	23:23:37	73° 54,459'	69° 08,679'
3	ba-06	Mooring	29-08-18	14:23:53	75° 39,463'	70° 24,797'
3	ba-05	Mooring	29-08-18	12:47:53	75° 48,259'	70° 12,361'
3	115	Basic	29-08-18	08:53:19	76° 19,728'	71° 08,292'
3	Site 1.5	Coring	31-08-18	20:31:24	67° 17,055'	63° 54,252'
3	177	Basic	01-09-18	18:06:51	67° 28,999'	63° 40,844'
3	Sunneshine fjord	Basic	03-09-18	13:20:16	66° 36,399'	61° 43,553'

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Leg	Station ID	Station Type	UTC Date	UTC Time	Latitude (N)	Longitude (W)	Activity	Depth (m)	Wind		Air (°C)	Water (°C)	Pr Baro	Hum (%)	Ice
									Dir	Speed					
Leg 1															
1	356	Nutrient	2018-05-31	17:45	60° 48,795'	64° 32,001'	Water Sampling ↓	328,75	277	16,8	0,1	4,705	1006,63	82	7
1	356	Nutrient	2018-05-31	18:00	60° 48,795'	64° 32,001'	CTD Rosette ↓	328,75	277	16,8	0,1	4,705	1006,63	82	7
1	356	Nutrient	2018-05-31	19:00	60° 49,720'	64° 41,785'	CTD Rosette ↑	390,1	260	1,1	1,8	4,75	1007,45	81	7
1	356	Nutrient	2018-05-31	19:20	60° 48,172'	64° 36,886'	Water Sampling ↓	354,57	276	19,2	-0,1	5,334	1006,83	84	7
1	354	Nutrient	2018-05-31	21:56	60° 58,410'	64° 46,400'	CTD Rosette ↓	571,13	289	3,8	0,7	-1,169	1007,62	77	2
1	354	Nutrient	2018-05-31	23:02	60° 58,051'	64° 48,388'	CTD Rosette ↑	582,93	68	0,6	-0,4	-1,196	1007,48	83	2
1	352	Nutrient	2018-06-01	0:14	61° 09,449'	64° 48,425'	Water Sampling ↓	441,4	233	11	0,1	-1,217	1007,05	85	1
1	352	Nutrient	2018-06-01	0:55	61° 09,011'	64° 48,521'	CTD Rosette ↓	430,12	230	15	-0,4	-1,118	1006,96	83	1
1	352	Nutrient	2018-06-01	1:56	61° 09,325'	64° 55,405'	CTD Rosette ↑	320,47	323	1,1	-0,1	-1,147	1006,93	82	1
1	HN01A	Nutrient	2018-06-01	14:00	62° 02,501'	69° 36,561'	Water Sampling ↓	286	316	10,7	-0,3	-1,037	1008,4	85	1
1	HN01A	Nutrient	2018-06-01	14:16	62° 02,431'	69° 36,796'	CTD Rosette ↓	285	274	12,4	-0,6	-1,016	1008,4	85	1
1	HN01A	Nutrient	2018-06-01	14:25	62° 02,434'	69° 36,743'	Water Sampling ↑	286,3	299	16	-0,5	-1,009	1008,63	78	1
1	HN01A	Nutrient	2018-06-01	15:03	62° 02,547'	69° 37,617'	CTD Rosette ↑	286	297	0,2	-1,1	-1	1009,03	85	1
1	HN01A	Nutrient	2018-06-01	15:11	62° 02,585'	69° 37,786'	Vertical tow ↓	287	309	12	0,4	-0,998	1009,01	76	1
1	HN01A	Nutrient	2018-06-01	15:30	62° 02,646'	69° 38,387'	Vertical tow ↑	287	303	12,8	0,5	-0,919	1009,19	79	1
1	HN01A	Nutrient	2018-06-01	16:23	62° 01,512'	69° 34,387'	Agassis trawl ↓	271	288	16,4	-1	-1,312	1009,68	84	1
1	HN01A	Nutrient	2018-06-01	16:44	62° 01,690'	69° 33,050'	Agassis trawl ↑	274,35	282	17,9	-2,2	-0,965	1009,73	89	1
1	FB01	Nutrient	2018-06-02	18:02	64° 05,007'	77° 12,146'	Helicopter ↓	346,27	293	26,3	-1,9	-1,254	1022,7	90	
1	FB01	Nutrient	2018-06-02	20:59	64° 17,105'	78° 13,666'	Helicopter ↑	237,49	319	12,4	-2,2	2,848	1024,79	90	
1	FB01	Nutrient	2018-06-02	21:32	64° 17,191'	78° 13,845'	CTD Rosette ↓	233,03	315	7	-0,8	1,355	1025,15	86	7
1	FB01	Nutrient	2018-06-02	21:32	64° 17,191'	78° 13,845'	Water Sampling ↓	233,03	315	7	-0,8	1,355	1025,15	86	7
1	FB01	Nutrient	2018-06-02	22:15	64° 17,105'	78° 12,726'	CTD Rosette ↑	245,82	277	7,4	-0,1	-1,571	1025,27	79	7
1	FB01	Nutrient	2018-06-02	22:44	64° 16,660'	78° 13,108'	Monster Net ↓	224,2	294	10,7	-2,3	-1,544	1025,38	88	7
1	FB01	Nutrient	2018-06-02	22:54	64° 16,540'	78° 12,637'	Monster Net Bot	225,49	283	11	-2,5	-1,56	1025,39	88	7
1	FB01	Nutrient	2018-06-02	23:03	64° 16,416'	78° 12,150'	Monster Net ↑	226,06	299	7,4	-2,4	-1,556	1025,41	88	7
1	FB01A	Nutrient	2018-06-03	1:16	64° 13,413'	78° 37,462'	CTD Rosette ↓	276,08	307	6,7	-2,1	1,746	1026,42	82	4
1	FB01A	Nutrient	2018-06-03	1:58	64° 12,621'	78° 35,301'	CTD Rosette ↑	270,19	290	6,3	-1,7	1,189	1026,33	85	4
1	FB02	Nutrient	2018-06-03	3:27	64° 03,915'	79° 03,743'	CTD Rosette ↓	270	308	12	-2,9	1,384	1026,57	89	5
1	FB02	Nutrient	2018-06-03	3:31	64° 03,902'	79° 03,729'	Water Sampling ↓	270	305	11,2	-2,7	1,281	1026,57	88	5
1	FB02	Nutrient	2018-06-03	5:48	63° 56,963'	79° 33,872'	CTD Rosette ↓	320,34	2	1,7	-2,5	1,148	1027,43	84	
1	FB02	Nutrient	2018-06-03	6:34	64° 03,704'	79° 03,716'	CTD Rosette ↑	274,98	111	0,2	-1,6	-1,68	1026,52	82	5
1	FB03	Basic	2018-06-03	7:52	63° 50,234'	79° 52,608'	Box core ↓	248,82	321	9,5	-3,9	-1,61	1027,96	82	5
1	FB03	Basic	2018-06-03	7:57	63° 50,257'	79° 52,727'	Box core (bottom)	250,36	319	14,5	-3,8	-1,603	1027,87	81	5
1	FB03	Basic	2018-06-03	8:06	63° 50,269'	79° 52,821'	Box core ↑	247,6	327	13,9	-4	-1,623	1027,85	80	5
1	FB03	Basic	2018-06-03	8:12	63° 50,297'	79° 52,890'	Box core ↓	249,08	310	15,6	-4	-1,624	1027,9	81	5
1	FB03	Basic	2018-06-03	8:18	63° 50,325'	79° 52,990'	Box core (bottom)	248,55	310	13,1	-3,8	-1,632	1027,95	81	5
1	FB03	Basic	2018-06-03	8:23	63° 50,343'	79° 53,097'	Box core ↑	251,07	317	12,6	-4	-1,633	1027,96	81	5
1	FB03	Basic	2018-06-03	8:51	63° 50,341'	79° 53,228'	Box core ↓	251,2	312	13,5	-4	-1,594	1028,19	81	5
1	FB03	Basic	2018-06-03	8:57	63° 50,347'	79° 53,323'	Box core (bottom)	249,33	306	14,3	-4,1	-1,591	1028,28	78	5
1	FB03	Basic	2018-06-03	9:03	63° 50,349'	79° 53,426'	Box core ↑	248,43	315	15,6	-3,9	-1,571	1028,19	78	5
1	FB03	Basic	2018-06-03	9:28	63° 50,322'	79° 54,002'	Box core ↓	244,11	306	13,1	-3,8	-1,562	1028,31	81	5
1	FB03	Basic	2018-06-03	9:34	63° 50,297'	79° 54,039'	Box core (bottom)	244,16	299	16,2	-4,1	-1,588	1028,26	83	5
1	FB03	Basic	2018-06-03	9:42	63° 50,264'	79° 54,086'	Box core ↑	245,64	298	14,5	-4,3	-1,587	1028,37	81	5
1	FB03	Basic	2018-06-03	10:06	63° 56,872'	79° 34,402'	Agassis trawl ↓	322,88	345	8,6	-1	-1,63	1027,21	77	5
1	FB03	Basic	2018-06-03	10:29	63° 49,549'	79° 52,531'	Agassis trawl ↑	236,69	300	14,3	-4	-1,54	1028,46	79	5
1	FB03	Basic	2018-06-03	10:55	63° 48,250'	79° 54,223'	Beam Trawl ↓	224,64	315	14,3	-3,8	-1,507	1028,47	78	5
1	FB03	Basic	2018-06-03	11:44	63° 47,916'	79° 50,640'	Beam Trawl ↑	222,45	304	4,4	-3,9	-1,503	1029,01	81	5
1	FB03	Basic	2018-06-03	13:56	63° 44,954'	79° 55,940'	Ice team ↓	114,21	327	11	-3,8	-1,488	1029,6	78	3

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1	FB03	Basic	2018-06-03	14:12	63° 44,599'	79° 55,491'	PNF ↓	113,77	268	3,6	-2,7	-1,414	1029,54	75	3
1	FB03	Basic	2018-06-03	14:24	63° 44,384'	79° 55,347'	PNF ↑	114,69	111	1,1	-2,5	-1,384	1029,52	74	3
1	FB03	Basic	2018-06-03	14:52	63° 43,813'	79° 55,586'	CTD Rosette ↓	103	350	10,1	-3,6	-1,307	1029,62	77	3
1	FB03	Basic	2018-06-03	15:24	63° 43,323'	79° 55,972'	CTD Rosette ↑	105	298	1,1	-2,2	-1,234	1029,56	72	3
1	FB03	Basic	2018-06-03	16:36	63° 43,603'	79° 55,893'	Monster Net ↓	103,73	164	8,2	-3,6	-1,266	1029,5	78	1
1	FB03	Basic	2018-06-03	16:41	63° 43,680'	79° 55,996'	Monster Net ↑	104,2	322	6,3	-2,8	-1,294	1029,55	76	1
1	FB03	Basic	2018-06-03	17:03	63° 43,812'	79° 56,171'	Optics IOP ↓	109,39	297	4,4	-1,8	-1,218	1029,48	74	1
1	FB03	Basic	2018-06-03	17:31	63° 44,018'	79° 56,394'	Optics IOP ↑	107,85	298	1,5	-1,8	-1,086	1029,39	73	1
1	FB03	Basic	2018-06-03	17:35	63° 44,056'	79° 56,437'	Optics Lisst ↓	107,45	338	5	-1,2	-1,08	1029,34	70	1
1	FB03	Basic	2018-06-03	17:48	63° 44,195'	79° 56,548'	Optics Lisst ↑	108,9	261	1,5	-1,8	-1,068	1029,35	75	1
1	FB03	Basic	2018-06-03	19:11	63° 45,598'	79° 58,696'	Ice team ↑	155,22	359	7,2	-1,1	-1,145	1029,52	72	1
1	FB03	Basic	2018-06-03	19:33	63° 45,545'	79° 59,228'	Skippy boat ↑	182,6	7	1,3	-1,2	-1,317	1029,4	73	1
1	FB03	Basic	2018-06-03	20:19	63° 43,257'	79° 55,255'	Water Sampling ↓	96,9	351	6,5	-3,2	-1,307	1029,59	78	3
1	FB03	Basic	2018-06-03	20:22	63° 43,208'	79° 55,254'	CTD Rosette ↓	94,15	5	2,9	-2	-1,303	1029,56	74	3
1	FB03	Basic	2018-06-03	20:50	63° 43,325'	79° 55,183'	CTD Rosette ↑	98,56	77	1	-1,5	-1,24	1029,57	71	3
1	FB03	Basic	2018-06-03	20:55	63° 43,327'	79° 55,146'	Water Sampling ↑	96,6	57	1	-1,3	-1,24	1029,62	73	3
1	FB03	Basic	2018-06-03	21:10	63° 43,826'	79° 57,322'	Tucker Net ↓	118,16	339	7,6	-3,2	-1,218	1029,63	78	1
1	FB03	Basic	2018-06-03	21:24	63° 44,094'	79° 56,291'	Tucker Net ↑	107,18	345	6,7	-3,3	-1,265	1029,67	77	1
1			2018-06-04	0:04	63° 38,998'	79° 40,345'	MVP ↓	168	344	6,5	-2,6	-1,301	1029,64	74	1
1			2018-06-04	1:13	63° 33,583'	79° 35,668'	MVP ↑	181,49	12	7,6	-3,3	-1,194	1029,78	78	1
1	BS# 10	Basic	2018-06-04	2:03	63° 26,844'	79° 26,567'	CTD Rosette ↓	201,58	359	7,6	-3,6	-1,325	1029,77	79	1
1	BS# 10	Basic	2018-06-04	2:09	63° 26,763'	79° 26,496'	Water Sampling ↓	199	4	6,9	-3,6	-1,343	1029,78	77	1
1	BS# 10	Basic	2018-06-04	2:27	63° 26,534'	79° 26,371'	Water Sampling ↑	203,15	126	1,9	-2,7	-1,271	1029,71	77	1
1	BS# 10	Basic	2018-06-04	2:41	63° 26,378'	79° 26,384'	CTD Rosette ↑	204,47	220	0,8	-3,1	-1,279	1029,64	77	1
1	BS# 10	Basic	2018-06-04	3:11	63° 26,994'	79° 26,754'	Tucker Net ↓	201,84	9	6,7	-3,6	-1,329	1029,48	78	1
1	BS# 10	Basic	2018-06-04	3:27	63° 27,321'	79° 25,813'	Tucker Net ↑	197	17	9,5	-3,5	-1,238	1029,39	81	1
1	BS# 10	Basic	2018-06-04	4:26	63° 26,989'	79° 26,814'	Monster Net ↓	202,04	36	8,4	-3,9	-1,407	1029,32	83	1
1	BS# 10	Basic	2018-06-04	4:39	63° 27,021'	79° 26,881'	Monster Net ↑		11	4	-3,1	-1,45	1029,24	82	1
1	BS# 10	Basic	2018-06-04	5:27	63° 27,012'	79° 26,672'	Box core ↓	202,73	34	4,6	-3,3	-1,42	1029,08	83	1
1	BS# 10	Basic	2018-06-04	5:32	63° 27,042'	79° 26,711'	Box core (bottom)		27	6,1	-3,9	-1,298	1029,04	85	1
1	BS# 10	Basic	2018-06-04	5:37	63° 27,058'	79° 26,773'	Box core ↑	202,56	21	6,9	-4,1	-1,384	1028,99	85	1
1	BS# 10	Basic	2018-06-04	5:53	63° 27,195'	79° 26,970'	Agassis trawl ↓		35	2,5	-3,3	-1,363	1028,97	84	1
1	BS# 10	Basic	2018-06-04	6:08	63° 26,900'	79° 27,450'	Agassis trawl ↑	203,57	1	6,1	-3,6	-1,323	1028,91	85	1
1	BS# 10	Basic	2018-06-04	6:37	63° 27,430'	79° 26,206'	Beam Trawl ↓	201,95	324	4,6	-4,1	-1,234	1028,86	87	1
1	BS# 10	Basic	2018-06-04	7:11	63° 26,686'	79° 26,449'	Beam Trawl ↑	204,38	23	5	-4,2	5	1028,94	87	1
1	BS# 11	Basic	2018-06-04	12:59	62° 51,994'	78° 54,544'	PNF ↓	318,45	12	4,2	-2,7	4,2	1028,29	82	9
1	BS# 11	Basic	2018-06-04	13:05	62° 51,975'	78° 54,446'	PNF ↑	318,59	36	3,6	-2,5	3,6	1028,25	80	9
1	BS# 11	Basic	2018-06-04	13:34	62° 51,902'	78° 53,905'	CTD Rosette ↓	320,87	53	2,1	-2,2	2,449	1028,19	80	9
1	BS# 11	Basic	2018-06-04	14:08	62° 51,875'	78° 53,352'	CTD Rosette ↑	322,12	48	2,9	-1,9	1,668	1028,08	78	9
1	BS# 11	Basic	2018-06-04	15:20	62° 51,995'	78° 52,143'	Monster Net ↓	323,79	63	5,7	-3,4	-1,631	1027,59	85	9
1	BS# 11	Basic	2018-06-04	15:42	62° 52,049'	78° 51,833'	Monster Net ↑	322,47	48	3,4	-3,4	-1,516	1027,59	85	9
1	BS# 11	Basic	2018-06-04	16:34	62° 52,185'	78° 51,385'	Box core ↓	319,23	337	6,7	-3,3	-1,515	1027,2	85	9
1	BS# 11	Basic	2018-06-04	16:41	62° 52,207'	78° 51,345'	Box core (bottom)	318,13	334	5,5	-3,3	-1,521	1027,21	84	9
1	BS# 11	Basic	2018-06-04	16:49	62° 52,224'	78° 51,322'	Box core ↑	318,68	322	4,6	-3,5	-1,601	1027,14	85	9
1	BS# 11	Basic	2018-06-04	17:08	62° 52,273'	78° 51,287'	Helicopter ↑	318,75	329	5,7	-3,4	-1,524	1027,02	84	9
1	BS# 11	Basic	2018-06-04	17:31	62° 52,377'	78° 51,285'	Ice team ↓		349	4,6	-2,9	-1,598	1026,89	81	9
1	BS# 11	Basic	2018-06-04	18:48	62° 52,561'	78° 51,770'	Helicopter ↓	316,25	13	7	-2,6	-1,613	1026,34	80	9
1	BS# 11	Basic	2018-06-04	18:57	62° 52,589'	78° 51,823'	CTD Rosette ↓	315,56	345	7,2	-2,5	-1,566	1026,39	81	9
1	BS# 11	Basic	2018-06-04	19:47	62° 52,661'	78° 52,420'	CTD Rosette ↑	314,04	4	7	-2,4	-1,602	1025,94	81	9
1	BS# 11	Basic	2018-06-04	20:15	62° 52,699'	78° 52,690'	Ice team ↑	313,81	327	7	-2	-1,433	1025,92	80	9
1	BS# 11	Basic	2018-06-04	20:27	62° 52,688'	78° 52,824'	Optics IOP ↓	314,18	330	5,1	-2,4	-1,588	1025,91	80	9
1	BS# 11	Basic	2018-06-04	21:02	62° 52,673'	78° 53,213'	Optics IOP ↑	315,14	322	8	-2,2	-1,475	1025,71	81	9

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1	BS# 11	Basic	2018-06-04	21:06	62° 52,669'	78° 53,240'	Optics Lisst ↓	315,26	322	5	-2,2	-1,564	1025,73	81	9
1	BS# 11	Basic	2018-06-04	21:13	62° 52,658'	78° 53,304'	Optics Lisst ↑	315,83	323	5	-2,5	-1,545	1025,73	81	9
1	BS# 11	Basic	2018-06-04	21:20	62° 52,647'	78° 53,364'	Optics IOP ↓	315,96	302	4	-2,3	-1,57	1025,76	82	9
1	BS# 11	Basic	2018-06-04	21:29	62° 52,624'	78° 53,441'	Optics IOP ↑	316,13	322	5,7	-2,2	-1,551	1025,65	83	9
1	BS# 11	Basic	2018-06-04	22:45	62° 52,298'	78° 53,628'	Helicopter ↑	320,62	344	7	-2,7	-1,597	1025,11	86	9
1	BS# 12	Nutrient	2018-06-05	7:47	63° 23,745'	81° 13,465'	CTD Rosette ↓	85,78	262	4,8	-1,6	-1,197	1023,06	99	2
1	BS# 12	Nutrient	2018-06-05	8:13	63° 23,794'	81° 13,746'	CTD Rosette ↑	85,23	271	6,1	-1,2	-1,084	1022,94	99	2
1			2018-06-05	9:25	63° 17,767'	81° 34,055'	MVP ↓	130,02	263	9,9	-2,7	-1,157	1022,66	98	1
1			2018-06-05	9:45	63° 16,805'	81° 38,335'	MVP ↑	135,66	272	14,1	-2,5	-1,073	1022,69	98	1
1	BS# 13	Nutrient	2018-06-05	10:02	63° 15,877'	81° 40,250'	CTD Rosette ↓	148,03	260	3	-2,1	-1,042	1022,7	98	2
1	BS# 13	Nutrient	2018-06-05	10:35	63° 15,696'	81° 39,960'	CTD Rosette ↑	148,45	286	10,1	-2,7	-0,952	1022,74	98	2
1	BS# 14	Nutrient	2018-06-05	11:31	63° 11,803'	81° 51,341'	CTD Rosette ↓		305	6,7	-4,1	-1,633	1022,84	97	2
1	BS# 14	Nutrient	2018-06-05	11:46	63° 11,781'	81° 51,123'	CTD Rosette ↑	184,72	297	3	-3	-1,61	1022,67	97	2
1	BS# 15	Basic	2018-06-05	13:29	63° 10,990'	81° 58,879'	Mooring ↓	194,59	232	5	-3,6	-1,569	1022,66	97	
1	BS# 15	Basic	2018-06-05	14:17	63° 11,410'	81° 56,209'	PNF ↓	190,27	328	5,3	-2,8	-1,522	1022,53	97	5
1	BS# 15	Basic	2018-06-05	14:23	63° 11,479'	81° 56,032'	PNF ↑	189,45	342	5	-2,7	-1,457	1022,55	98	5
1	BS# 15	Basic	2018-06-05	14:42	63° 11,606'	81° 55,387'	CTD Rosette ↓	187,96	270	2,3	-1,8	-1,521	1022,5	97	5
1	BS# 15	Basic	2018-06-05	15:15	63° 11,625'	81° 54,236'	CTD Rosette ↑	189,49	264	0,6	-1,5	-1,425	1022,44	97	5
1	BS# 15	Basic	2018-06-05	15:34	63° 10,760'	81° 53,179'	Tucker Net ↓	190,51	254	5,9	-2,4	-1,568	1022,32	96	5
1	BS# 15	Basic	2018-06-05	15:51	63° 10,296'	81° 52,597'	Tucker Net ↑	193,22	304	1,9	-1,4	-1,467	1022,31	97	5
1	BS# 15	Basic	2018-06-05	16:37	63° 10,377'	81° 51,873'	Monster Net ↓	193,69	352	4,8	-2,6	-1,32	1022,3	96	5
1	BS# 15	Basic	2018-06-05	16:52	63° 10,419'	81° 51,613'	Monster Net ↑	193,56	300	1,5	-2,9	-1,392	1022,32	96	5
1	BS# 15	Basic	2018-06-05	17:18	63° 10,525'	81° 51,150'	Skippy boat ↓	193,49	20	4	-2,6	-1,287	1022,25	96	5
1	BS# 15	Basic	2018-06-05	17:40	63° 10,510'	81° 50,986'	CTD Rosette ↓	189,97	351	4,6	-2,2	-1,305	1022,31	95	5
1	BS# 15	Basic	2018-06-05	18:22	63° 10,601'	81° 50,870'	CTD Rosette ↑	190,41	314	4,2	-2,9	-1,383	1022,17	95	5
1	BS# 15	Basic	2018-06-05	18:33	63° 10,620'	81° 50,848'	Optics IOP ↓	191,18	294	2,7	-2,8	-1,343	1022,1	96	5
1	BS# 15	Basic	2018-06-05	19:04	63° 10,718'	81° 50,917'	Optics IOP ↑	191,4	301	2,3	-1	-1,515	1022,04	95	5
1	BS# 15	Basic	2018-06-05	19:08	63° 10,734'	81° 50,929'	Optics Lisst ↓	191,69	265	3	-2,1	-1,519	1022,02	95	5
1	BS# 15	Basic	2018-06-05	19:19	63° 10,788'	81° 50,955'	Optics Lisst ↑	191,39	254	2,1	-2,5	-1,523	1022,02	96	5
1	BS# 15	Basic	2018-06-05	19:30	63° 10,834'	81° 51,017'	Skippy boat ↑	190,58	268	2,1	-1,9	-1,52	1021,93	96	5
1	BS# 15	Basic	2018-06-05	19:46	63° 10,828'	81° 51,485'	Optics IOP ↓	191,69	5	5,7	-1,3	-1,142	1021,77	94	5
1	BS# 15	Basic	2018-06-05	20:09	63° 11,050'	81° 51,332'	Optics IOP ↑	190,8	43	2,9	-2	-1,441	1021,66	91	5
1	BS# 15	Basic	2018-06-05	20:21	63° 11,073'	81° 51,563'	Box core ↓	190,39	47	3,2	-2,3	-1,526	1021,63	93	5
1	BS# 15	Basic	2018-06-05	20:24	63° 11,086'	81° 51,623'	Box core (bottom)	191,62	48	3,6	-2,3	-1,516	1021,65	92	5
1	BS# 15	Basic	2018-06-05	20:29	63° 11,104'	81° 51,722'	Box core ↑	190,6	42	3,2	-2,1	-1,484	1021,6	92	5
1	BS# 15	Basic	2018-06-05	20:49	63° 11,116'	81° 51,914'	Box core ↓	189,59	336	4,4	-3	-1,303	1021,61	94	5
1	BS# 15	Basic	2018-06-05	20:54	63° 11,121'	81° 51,917'	Box core (bottom)	189,31	337	3,2	-2,8	-1,367	1021,64	94	5
1	BS# 15	Basic	2018-06-05	20:59	63° 11,134'	81° 51,931'	Box core ↑	189,58	2	1,1	-2,5	-1,392	1021,63	93	5
1	BS# 15	Basic	2018-06-05	21:14	63° 11,213'	81° 51,851'	Agassis trawl ↓	188,6	78	3,2	-2,2	-1,172	1021,43	94	5
1	BS# 15	Basic	2018-06-05	21:29	63° 11,501'	81° 52,316'	Agassis trawl ↑	189,28	338	2,3	-1,9	-1,189	1021,37	93	5
1	BS# 15	Basic	2018-06-05	22:06	63° 09,055'	81° 46,824'	Beam Trawl ↓	202,59	317	5	-2,4	-1,262	1021,13	92	5
1	BS# 15	Basic	2018-06-05	22:39	63° 08,618'	81° 47,942'	Beam Trawl ↑	200,83	11	0,6	-2,3	-1,05	1021,06	92	5
1	BS# 16	Ice	2018-06-06	15:28	62° 16,499'	85° 54,964'	PNF ↓	138,43	95	5,9	-4,1	-1,546	1016,02	96	9
1	BS# 16	Ice	2018-06-06	15:30	62° 16,504'	85° 54,953'	PNF ↑	138,45	102	5,9	-4,3	-1,537	1016,03	96	9
1	BS# 16	Ice	2018-06-06	16:27	62° 16,765'	85° 54,352'	CTD Rosette ↓	136,81	152	4,2	-3,9	-1,403	1015,59	96	9
1	BS# 16	Ice	2018-06-06	17:02	62° 16,798'	85° 54,438'	CTD Rosette ↑	136,62	95	3	-2,9	-1,464	1015,23	96	9
1	BS# 16	Ice	2018-06-06	17:20	62° 17,243'	85° 54,043'	Tucker net ↓	136,84	104	5	-3,3	-1,548	1015,2	94	9
1	BS# 16	Ice	2018-06-06	17:34	62° 16,978'	85° 54,544'	Tucker net ↑	137,18	99	3,2	-4	-1,509	1015,15	94	9
1	BS# 16	Ice	2018-06-06	17:53	62° 16,993'	85° 54,282'	Monster net ↓	136,79	70	5,1	-2	-1,55	1014,97	88	9
1	BS# 16	Ice	2018-06-06	18:02	62° 16,987'	85° 54,226'	Monster net ↑	136,58	84	5	-3	-1,54	1014,9	89	9
1	BS# 16	Ice	2018-06-06	18:44	62° 16,693'	85° 53,513'	Ice team ↑	135,14	82	5,1	-2,5	-1,577	1014,69	88	9
1	BS# 16	Ice	2018-06-06	18:56	62° 16,855'	85° 53,033'	Optics IOP ↓	135	36	5	-3,6	-1,49	1014,66	88	9

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1	BS# 16	Ice	2018-06-06	19:20	62° 16,929'	85° 52,825'	Optics IOP ↑	134,22	76	3,8	-3,4	-1,413	1014,63	86	9
1	BS# 16	Ice	2018-06-06	19:25	62° 16,947'	85° 52,776'	Optics Lisst ↓	134,14	86	3,8	-3,5	-1,484	1014,57	87	9
1	BS# 16	Ice	2018-06-06	19:36	62° 16,972'	85° 52,646'	Optics Lisst ↑	134,05	39	1,1	-3,4	-1,373	1014,5	84	9
1	BS# 16	Ice	2018-06-06	19:50	62° 16,985'	85° 52,489'	Skippy boat ↑	133,99	51	2,1	-2,6	-1,464	1014,36	82	9
1	BS# 16	Ice	2018-06-06	20:09	62° 17,111'	85° 52,321'	Optics IOP ↓	134,72	92	1,7	-3,1	-1,462	1014,29	86	9
1	BS# 16	Ice	2018-06-06	20:34	62° 17,259'	85° 52,044'	Optics IOP ↑	134,99	172	2,1	-2,9	-1,474	1014,17	88	9
1	BS# 16	Ice	2018-06-06	20:50	62° 17,237'	85° 51,912'	Helicopter ↓	134,73	203	1,7	-2,9	-1,392	1014,1	87	9
1	BS# 16	Ice	2018-06-06	21:28	62° 17,338'	85° 51,490'	CTD Rosette ↓	134,24	189	0,2	-1,5	-1,282	1013,94	80	9
1	BS# 16	Ice	2018-06-06	22:02	62° 17,535'	85° 51,350'	CTD Rosette ↑	134,92	290	0,4	-1,3	-1,298	1013,78	80	9
1	BS# 16	Ice	2018-06-06	22:18	62° 17,741'	85° 51,249'	Box core ↓	135,69	253	2,7	-3,1	-1,475	1013,64	84	9
1	BS# 16	Ice	2018-06-06	22:22	62° 17,749'	85° 51,229'	Box core (bottom)	135,62	263	3,6	-3,1	-1,485	1013,59	85	9
1	BS# 16	Ice	2018-06-06	22:24	62° 17,753'	85° 51,215'	Box core ↑	135,68	260	3,8	-3,3	-1,483	1013,56	85	9
1	BS# 16	Ice	2018-06-06	22:35	62° 17,762'	85° 51,145'	Agassis trawl ↓	135,66	268	3,6	-3,4	-1,332	1013,46	86	9
1	BS# 16	Ice	2018-06-06	22:50	62° 18,067'	85° 51,199'	Agassis trawl ↑	136,32	249	4	-3,4	-1,381	1013,19	86	9
1	BS# 16	Ice	2018-06-06	23:06	62° 17,917'	85° 51,290'	Helicopter ↓	135,82	280	3,4	-3,4	-1,367	1013,09	85	9
1	BS# 16	Ice	2018-06-06	23:16	62° 17,948'	85° 51,539'	Helicopter ↑	135,96	314	5,1	-3,1	-1,483	1012,99	85	9
1	BS# 16	Ice	2018-06-06	23:35	62° 18,061'	85° 51,559'	Agassis trawl ↓	136	335	3,8	-3,2	-1,486	1013,08	85	9
1	BS# 16	Ice	2018-06-06	23:56	62° 18,719'	85° 51,403'	Agassis trawl ↑	135,97	304	5,5	-3,2	-1,441	1012,99	86	9
1			2018-06-07	8:05	62° 52,115'	88° 55,417'	MVP ↓	192,26	303	20	-1,6	-0,236	1011,54	86	1
1			2018-06-07	8:05	62° 52,115'	88° 55,417'	MVP ↑	192,26	303	20	-1,6	-0,236	1011,54	86	1
1	BS# 17	Basic	2018-06-07	20:03	63° 17,580'	90° 28,450'	Helicopter ↑	65,15	321	14,3	1,3	-1,178	1013,74	84	1
1	BS# 17	Basic	2018-06-07	21:52	63° 11,078'	90° 02,143'	CTD Rosette ↓	88,43	310	7,8	3,7	-0,573	1014,25	77	0
1	BS# 17	Basic	2018-06-07	22:19	63° 11,017'	90° 01,785'	CTD Rosette ↑	92,47	306	10,7	0,5	-0,555	1014,22	88	0
1	BS# 17	Basic	2018-06-07	22:27	63° 11,031'	90° 01,810'	Optics IOP ↓	93,92	299	7	2,5	-0,746	1014,33	79	0
1	BS# 17	Basic	2018-06-07	22:53	63° 11,119'	90° 01,321'	Optics IOP ↑	88,51	292	2,7	2	-0,501	1014,51	84	0
1	BS# 17	Basic	2018-06-07	23:10	63° 11,139'	90° 02,095'	Monster Net ↓	94,52	305	13,1	0,9	-0,568	1014,57	87	0
1	BS# 17	Basic	2018-06-07	23:18	63° 11,115'	90° 02,105'	Monster Net ↑	93,21	304	12,6	0,9	-0,612	1014,42	87	0
1	BS# 17	Basic	2018-06-07	23:42	63° 10,953'	90° 01,974'	Box core ↓	82,74	316	13,9	0,9	-0,541	1014,53	86	0
1	BS# 17	Basic	2018-06-07	23:44	63° 10,951'	90° 01,964'	Box core (bottom)	81,32	316	10,3	4,6	-0,876	1014,56	72	0
1	BS# 17	Basic	2018-06-07	23:47	63° 10,955'	90° 01,950'	Box core ↑	81,47	313	11	5,9	-0,826	1014,61	68	0
1	BS# 17	Basic	2018-06-08	0:05	63° 11,077'	90° 02,061'	Box core ↓	90,61	325	11	3,2	-0,75	1014,76	79	0
1	BS# 17	Basic	2018-06-08	0:08	63° 11,074'	90° 02,018'	Box core (bottom)	91,62	293	8,8	2,5	-0,639	1014,71	83	0
1	BS# 17	Basic	2018-06-08	0:10	63° 11,062'	90° 01,970'	Box core ↑	91,89	19	0	1,9	-0,554	1014,77	83	0
1	BS# 17	Basic	2018-06-08	0:40	63° 11,040'	90° 01,939'	Agassis trawl ↓	94,46	308	11,8	1,5	-0,446	1014,86	84	0
1	BS# 17	Basic	2018-06-08	0:48	63° 11,194'	90° 01,626'	Agassis trawl ↑	87,05	312	12,6	1,3	-0,409	1014,82	85	0
1	BS# 18	Full	2018-06-08	5:37	63° 43,243'	88° 23,912'	Box core ↓	116,92	313	11,2	1	-0,973	1015,4	80	1
1	BS# 18	Full	2018-06-08	5:40	63° 43,218'	88° 23,960'	Box core (bottom)	117,09	313	10,7	0,4	-1,016	1015,35	80	1
1	BS# 18	Full	2018-06-08	5:42	63° 43,199'	88° 23,964'	Box core ↑	120,23	311	10,5	0,2	-1,057	1015,46	80	1
1	BS# 18	Full	2018-06-08	6:07	63° 43,181'	88° 24,113'	Box core ↓	122,09	310	8,4	2,3	-1,112	1015,59	73	1
1	BS# 18	Full	2018-06-08	6:10	63° 43,180'	88° 24,127'	Box core (bottom)	122,15	333	7	2,9	-1,115	1015,63	71	1
1	BS# 18	Full	2018-06-08	6:13	63° 43,176'	88° 24,143'	Box core ↑	121,7	345	8	3,5	-1,111	1015,64	66	1
1	BS# 18	Full	2018-06-08	6:25	63° 43,251'	88° 24,254'	Agassis trawl ↓	118,97	341	12	0,9	-1,1	1015,67	74	1
1	BS# 18	Full	2018-06-08	6:34	63° 43,461'	88° 24,288'	Agassis trawl ↑	118,8	338	13,7	0,7	-1,1	1015,79	75	1
1	BS# 18	Full	2018-06-08	7:46	63° 43,917'	88° 26,223'	Beam Trawl ↓	114,13	321	1,9	0,4	-0,659	1016,56	80	1
1	BS# 18	Full	2018-06-08	8:08	63° 43,163'	88° 25,347'	Beam Trawl ↑	114,36	314	7,6	-0,3	-0,978	1016,67	82	1
1	BS# 18	Full	2018-06-08	8:34	63° 42,820'	88° 25,009'	CTD Rosette ↓	115,61	309	5,9	0,8	-1,102	1016,9	79	9
1	BS# 18	Full	2018-06-08	9:04	63° 42,703'	88° 25,029'	CTD Rosette ↑	117,96	291	3,8	1	-1,228	1017,18	79	9
1	BS# 18	Full	2018-06-08	9:25	63° 43,942'	88° 26,097'	Tucker Net ↓	115,14	337	6,3	0,8	-1,015	1017,28	75	9
1	BS# 18	Full	2018-06-08	9:40	63° 43,942'	88° 26,097'	Tucker Net ↑	115,14	337	6,3	0,8	-1,015	1017,28	75	9
1	BS# 18	Full	2018-06-08	9:58	63° 42,784'	88° 25,678'	Monster Net ↓	116,5	342	8,8	-0,1	-1,102	1017,41	77	9
1	BS# 18	Full	2018-06-08	10:06	63° 42,760'	88° 25,740'	Monster Net ↑	117,12	336	8,9	0,3	-1,08	1017,54	79	9
1	BS# 18	Full	2018-06-08	12:27	63° 42,623'	88° 25,582'	Mooring ↓	118,75	312	7,4	-0,5	-1,112	1018,42	79	

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1	BS# 18	Full	2018-06-08	12:55	63° 44,077'	88° 26,394'	PNF ↓	111,8	313	7,6	-0,5	-0,756	1018,58	80	3
1	BS# 18	Full	2018-06-08	12:59	63° 44,081'	88° 26,412'	PNF ↑	112,26	308	8,6	-0,3	-0,75	1018,59	81	3
1	BS# 18	Full	2018-06-08	13:32	63° 44,018'	88° 26,212'	CTD Rosette ↓	112,99	338	8	0,3	-0,637	1018,94	79	3
1	BS# 18	Full	2018-06-08	14:00	63° 43,942'	88° 26,140'	CTD Rosette ↑	116,74	339	6,7	0,3	-0,632	1018,92	80	3
1	BS# 18	Full	2018-06-08	14:23	63° 43,868'	88° 26,097'	Optics Open Water/Sunlight ↓	117,06	298	5,7	0,1	-0,717	1019,02	80	3
1	BS# 18	Full	2018-06-08	14:47	63° 43,801'	88° 25,966'	Optics Open Water/Sunlight ↑	117,72	339	1,1	1,9	-0,763	1019,09	74	3
1	BS# 18	Full	2018-06-08	14:50	63° 43,797'	88° 25,939'	Optics Open Water/Sunlight ↓	118,11	324	1,3	2,1	-0,747	1019,13	74	3
1	BS# 18	Full	2018-06-08	15:02	63° 43,768'	88° 25,822'	Optics Open Water/Sunlight ↑	119,35	279	0,2	2,2	-0,749	1019,14	74	3
1	BS# 18	Full	2018-06-08	15:08	63° 43,741'	88° 25,773'	Optics IOP ↓	118,9	321	2,5	2,1	-0,722	1019,09	74	3
1	BS# 18	Full	2018-06-08	15:43	63° 43,843'	88° 25,549'	Optics IOP ↑	117,62	310	6,9	1,6	-0,832	1019,23	75	3
1	BS# 18	Full	2018-06-08	16:55	63° 44,440'	88° 18,366'	Helicopter ↑	127,45	295	8,4	0,6	-0,994	1019,52	81	3
1	BS# 18	Full	2018-06-08	17:09	63° 44,458'	88° 18,405'	Skippy boat ↓	129,77	285	7,2	0,3	-1,12	1019,59	84	3
1	BS# 18	Full	2018-06-08	17:33	63° 44,181'	88° 18,480'	Ice team ↓	123,13	297	8,6	1	-1,209	1019,54	82	3
1	BS# 18	Full	2018-06-08	18:50	63° 43,885'	88° 18,400'	Helicopter ↓	124,34	248	2,7	3,1	-1,157	1020,13	74	3
1	BS# 18	Full	2018-06-08	19:16	63° 43,941'	88° 18,843'	Hydrobios ↓	121,33	270	6,1	0,8	-0,964	1020,09	81	3
1	BS# 18	Full	2018-06-08	19:25	63° 43,896'	88° 18,789'	Hydrobios ↑	121,34	263	6,7	0,8	-0,931	1020,14	83	3
1	BS# 18	Full	2018-06-08	20:10	63° 43,561'	88° 19,401'	Ice team ↑	126,72	296	5,7	2,3	-1,095	1020,21	77	3
1	BS# 18	Full	2018-06-08	20:20	63° 43,599'	88° 19,442'	Skippy boat ↑	125,12	284	6,9	1,4	-0,969	1020,29	80	3
1	BS# 18	Full	2018-06-08	23:40	63° 24,205'	89° 25,693'	Helicopter ↑	88,3	243	19	1,9	1,227	1020,97	85	0
1	BS# 19	Basic	2018-06-09	10:39	61° 50,414'	92° 08,560'	Monster Net ↓	76,4	160	6,1	5,1	-0,757	1020,99	66	1
1	BS# 19	Basic	2018-06-09	10:45	61° 50,424'	92° 08,427'	Monster Net ↑	77,26	203	15,6	1,8	-0,794	1021	82	1
1	BS# 19	Basic	2018-06-09	11:00	61° 50,424'	92° 08,427'	Tucker Net ↓	77,26	203	15,6	1,8	-0,794	1021	82	1
1	BS# 19	Basic	2018-06-09	11:21	61° 51,454'	92° 08,574'	Tucker Net ↑	72,57	199	15,2	1,6	-0,332	1020,79	82	1
1	BS# 19	Basic	2018-06-09	12:11	61° 50,493'	92° 07,028'	PNF ↓	73,73	204	12,2	2,1	-0,385	1020,79	81	1
1	BS# 19	Basic	2018-06-09	12:20	61° 50,554'	92° 06,711'	PNF ↑	81	200	12,8	2,1	-0,455	1020,92	80	1
1	BS# 19	Basic	2018-06-09	12:34	61° 50,810'	92° 06,774'	CTD Rosette ↓	74,89	223	0,2	3	-0,362	1020,66	77	1
1	BS# 19	Basic	2018-06-09	12:58	61° 51,208'	92° 06,120'	CTD Rosette ↑	77,63	208	2,5	2,8	-0,469	1020,27	76	1
1	BS# 19	Basic	2018-06-09	14:03	61° 51,254'	92° 06,446'	Optics ↓	79,5	191	15,2	2	-0,496	1019,76	79	1
1	BS# 19	Basic	2018-06-09	14:28	61° 51,575'	92° 06,422'	Optics ↑	81,46	179	12	2	-0,479	1019,74	80	1
1	BS# 19	Basic	2018-06-09	14:31	61° 51,607'	92° 06,422'	Optics ↓	82,33	180	13,9	2	-0,472	1019,58	81	1
1	BS# 19	Basic	2018-06-09	14:40	61° 51,666'	92° 06,488'	Optics ↑	78,58	166	12	1,7	-0,453	1019,49	82	1
1	BS# 19	Basic	2018-06-09	14:43	61° 51,705'	92° 06,507'	Optics IOP ↓	79,81	167	11,8	1,5	-0,416	1019,41	83	1
1	BS# 19	Basic	2018-06-09	15:09	61° 52,058'	92° 06,185'	Optics IOP ↑	81,52	167	11,8	1,5	-0,415	1019,46	84	1
1	BS# 19	Basic	2018-06-09	15:26	61° 50,791'	92° 07,933'	CTD Rosette ↓	78,33	167	8,2	2,1	-0,407	1019,42	83	1
1	BS# 19	Basic	2018-06-09	15:52	61° 50,875'	92° 08,142'	CTD Rosette ↑	83,83	144	7	5,5	-0,36	1019,12	70	1
1	BS# 19	Basic	2018-06-09	16:37	61° 50,629'	92° 07,805'	Zodiac ↓	88,82	171	11,2	1,1	-0,301	1019,46	87	1
1	BS# 19	Basic	2018-06-09	16:58	61° 50,605'	92° 07,901'	Box core ↓	88,51	170	13,3	1,7	-0,305	1019,2	87	0
1	BS# 19	Basic	2018-06-09	17:01	61° 50,608'	92° 07,898'	Box core (bottom)	88,37	167	13,1	1,3	-0,375	1019,2	88	0
1	BS# 19	Basic	2018-06-09	17:04	61° 50,609'	92° 07,879'	Box core ↑	88,4	165	12,9	1	-0,371	1019,11	89	0
1	BS# 19	Basic	2018-06-09	17:19	61° 50,589'	92° 07,965'	Box core ↓	86,09	171	13,5	1,6	-0,394	1019,07	89	0
1	BS# 19	Basic	2018-06-09	17:21	61° 50,589'	92° 07,966'	Box core (bottom)	86,18	169	14,5	1,3	-0,43	1019,05	90	0
1	BS# 19	Basic	2018-06-09	17:28	61° 50,598'	92° 07,967'	Box core ↑	87,53	171	16	0,9	-0,498	1018,86	90	0
1	BS# 19	Basic	2018-06-09	17:41	61° 50,647'	92° 08,028'	Agassis trawl ↓	85,92	171	10,3	5,7	-0,495	1018,63	75	0
1	BS# 19	Basic	2018-06-09	17:51	61° 50,882'	92° 08,373'	Agassis trawl ↑	82,87	161	15,4	0,9	-0,368	1018,28	92	0
1	BS# 19	Basic	2018-06-09	17:56	61° 50,893'	92° 08,306'	Agassis trawl ↓	83,28	164	14,3	2,1	-0,391	1018,48	81	0
1	BS# 19	Basic	2018-06-09	18:06	61° 51,088'	92° 08,689'	Agassis trawl ↑	73,07	154	14,7	0,7	-0,32	1018,4	93	0
1	BS# 19	Basic	2018-06-09	18:26	61° 50,210'	92° 07,958'	Beam trawl ↓	75,47	163	13,7	1,2	-0,217	1018,55	91	0
1	BS# 19	Basic	2018-06-09	18:50	61° 50,808'	92° 09,459'	Beam trawl ↑	78,04	152	13,1	0,8	-0,436	1018,5	91	0
1	BS# 19	Basic	2018-06-09	19:47	61° 50,809'	92° 08,007'	Helicopter ↑		159	19,4	1,4	-0,342	1017,98	90	0
1	BS# 19	Basic	2018-06-09	20:49	61° 50,673'	92° 10,216'	Zodiac ↑	63,29	135	17,1	1,3	-0,667	1017,28	86	0
1			2018-06-09	21:49	61° 50,574'	92° 08,271'	MVP ↓	81,22	143	31	1,8	-0,469	1016,09	83	0
1			2018-06-10	2:19	61° 22,615'	90° 57,228'	MVP ↑	111,08	156	24,4	2,2	0,357	1015,58	80	0

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1	BS# 20	Nutrient	2018-06-10	2:33	61° 22,455'	90° 56,520'	CTD Rosette ↓	112,15	151	20,9	1,9	0,028	1015,44	80	0
1	BS# 20	Nutrient	2018-06-10	3:01	61° 22,730'	90° 56,572'	CTD Rosette ↑	110,94	150	21,9	5,2	-0,065	1015,15	73	0
1			2018-06-10	3:16	61° 23,389'	90° 57,178'	MVP ↓	111,47	157	27,4	1,8	0,361	1014,79	80	0
1			2018-06-10	7:09	61° 00,090'	90° 04,748'	MVP ↑	138,73	175	22,7	1,6	-0,342	1015,02	77	0
1	BS# 21	Full	2018-06-10	10:34	60° 52,216'	89° 23,097'	Monster Net ↓		60	17,1	3,8	3,313	1015,44	70	8
1	BS# 21	Full	2018-06-10	10:44	60° 52,208'	89° 23,029'	Monster Net ↑		174	17,7	1,8	2,829	1015,62	75	8
1	BS# 21	Full	2018-06-10	11:16	60° 52,455'	89° 22,698'	Hydrobios ↓	146,58	166	16,2	2,8	-1,412	1015,17	76	8
1	BS# 21	Full	2018-06-10	11:26	60° 52,454'	89° 22,565'	Hydrobios ↑	147,2	172	17,1	1,7	-1,318	1015,32	77	8
1	BS# 21	Full	2018-06-10	12:16	60° 52,925'	89° 21,915'	Tucker Net ↓	146,59	176	19,8	1,9	-1,378	1014,72	78	6
1	BS# 21	Full	2018-06-10	12:35	60° 53,512'	89° 21,381'	Tucker Net ↑	149,1	150	14,3	1,4	-1,356	1014,86	80	6
1	BS# 21	Full	2018-06-10	13:00	60° 53,814'	89° 21,722'	PNF ↓	146,76	160	17,1	1,4	-1,338	1014,92	81	
1	BS# 21	Full	2018-06-10	13:09	60° 53,938'	89° 21,656'	PNF ↑	148,43	153	16,2	1,3	-1,335	1014,61	82	5
1	BS# 21	Full	2018-06-10	13:29	60° 54,289'	89° 21,479'	Helicopter ↓	149,64	155	14,3	1,4	-1,326	1014,55	82	5
1	BS# 21	Full	2018-06-10	13:30	60° 54,307'	89° 21,485'	Zodiac ↓	149,24	164	16	1,2	-1,328	1014,58	82	5
1	BS# 21	Full	2018-06-10	13:43	60° 54,609'	89° 21,567'	CTD Rosette ↓	149,58	293	2,3	2	-1,341	1014,56	80	5
1	BS# 21	Full	2018-06-10	14:12	60° 54,870'	89° 21,352'	CTD Rosette ↑	149,77	170	20,9	2,5	-1,23	1014,21	82	5
1	BS# 21	Full	2018-06-10	14:33	60° 55,178'	89° 21,155'	Zodiac ↑	151,3	167	14,7	1,3	-1,285	1014,04	84	5
1	BS# 21	Full	2018-06-10	15:19	60° 54,404'	89° 19,449'	Helicopter ↑	147,53	174	19,2	1,6	-1,221	1013,39	86	5
1	BS# 21	Full	2018-06-10	16:08	60° 54,529'	89° 19,255'	Optics IOP ↓		174	17,3	1,4	-1,278	1013,44	88	5
1	BS# 21	Full	2018-06-10	16:42	60° 54,604'	89° 19,622'	Optics IOP ↑	148,88	175	16,4	1,3	-1,178	1013,24	89	5
1	BS# 21	Full	2018-06-10	16:46	60° 54,613'	89° 19,645'	Optics Lisst ↓	148,74	181	17,3	1,4	-1,247	1013,12	89	5
1	BS# 21	Full	2018-06-10	16:57	60° 54,650'	89° 19,670'	Optics Lisst ↑	148,13	167	13,7	1,2	-1,194	1013,22	89	5
1	BS# 21	Full	2018-06-10	17:10	60° 54,366'	89° 19,847'	Optics IOP ↓	147,71	178	13,7	1,2	-1,244	1013,38	90	5
1	BS# 21	Full	2018-06-10	17:31	60° 54,546'	89° 19,836'	Optics IOP ↑	150,94	183	12,9	1,7	-1,212	1013,33	89	5
1	BS# 21	Full	2018-06-10	17:40	60° 54,621'	89° 19,761'	CTD Rosette ↓	149,3	182	10,5	3,7	-1,245	1013,49	79	5
1	BS# 21	Full	2018-06-10	18:17	60° 54,799'	89° 20,167'	CTD Rosette ↑	149,24	165	13,7	4,2	-1,168	1013,16	81	5
1	BS# 21	Full	2018-06-10	18:50	60° 54,365'	89° 20,808'	Ice cage ↓	148,03	170	15,4	1,6	-1,174	1012,99	91	5
1	BS# 21	Full	2018-06-10	19:08	60° 54,408'	89° 20,852'	Ice cage ↑	149,2	175	14,5	1,6	-1,169	1012,95	91	5
1	BS# 21	Full	2018-06-10	19:31	60° 54,276'	89° 20,771'	Ice cage ↓	150,43	169	14,3	1,6	-1,215	1012,93	90	5
1	BS# 21	Full	2018-06-10	20:40	60° 54,333'	89° 20,967'	Ice cage ↑	148,11	156	15,6	1,7	-1,052	1012,4	91	5
1	BS# 21	Full	2018-06-10	21:04	60° 54,849'	89° 20,293'	Box core ↓	148,51	158	14,3	2,2	-0,946	1012,4	88	5
1	BS# 21	Full	2018-06-10	21:08	60° 54,844'	89° 20,311'	Box core (bottom)	148,93	155	12	1,9	-1,029	1012,43	90	5
1	BS# 21	Full	2018-06-10	21:14	60° 54,820'	89° 20,374'	Box core ↑	149,64	113	14,9	2,3	-1,105	1012,27	90	5
1	BS# 21	Full	2018-06-10	21:32	60° 54,978'	89° 20,607'	Agassis trawl ↓	150,76	150	9,3	5,3	-0,931	1012,33	76	5
1	BS# 21	Full	2018-06-10	21:45	60° 55,122'	89° 21,130'	Agassis trawl ↑	151,81	137	13,3	1,6	-0,928	1011,8	91	5
1	BS# 21	Full	2018-06-10	21:46	60° 55,123'	89° 21,177'	Agassis trawl ↓	151,85	139	13,9	1,8	-0,932	1011,99	91	5
1	BS# 21	Full	2018-06-10	21:59	60° 54,972'	89° 22,064'	Agassis trawl ↑	152,07	157	14,9	1,8	-0,97	1011,92	90	5
1	BS# 21	Full	2018-06-10	22:17	60° 55,278'	89° 20,357'	Beam Trawl ↓	151,68	141	8,8	2,8	-0,846	1011,87	87	5
1	BS# 21	Full	2018-06-10	22:48	60° 55,385'	89° 22,785'	Beam Trawl ↑	157,46	165	15,2	1,6	-1,242	1011,71	91	5
1	BS# 22	Full	2018-06-11	10:52	60° 25,159'	94° 00,655'	Tucker Net ↓	61	163	7,6	4,5	2,645	1002,98	86	0
1	BS# 22	Full	2018-06-11	11:07	60° 25,039'	94° 01,487'	Tucker Net ↑	63,92	154	8,2	4,7	2,635	1002,79	85	0
1	BS# 22	Full	2018-06-11	12:49	60° 25,364'	94° 00,154'	Helicopter ↓	65,63	127	8,4	4,7	1,231	1002,26	84	0
1	BS# 22	Full	2018-06-11	13:04	60° 25,387'	94° 00,139'	CTD Rosette ↓	239,9	130	10,7	4,5	0,832	1002,1	86	0
1	BS# 22	Full	2018-06-11	13:31	60° 25,489'	94° 00,112'	CTD Rosette ↑	60,47	135	2,3	6	1,371	1001,88	81	0
1	BS# 22	Full	2018-06-11	13:40	60° 25,522'	94° 00,129'	Monster Net ↓		133	1,3	5,1	1,406	1001,86	84	0
1	BS# 22	Full	2018-06-11	13:46	60° 25,561'	94° 00,118'	Monster Net ↑	58,4	126	3	6	1,458	1001,9	79	0
1	BS# 22	Full	2018-06-11	14:35	60° 25,245'	94° 00,218'	CTD Rosette ↓	63,56	103	9,5	4,7	1,979	1001,92	86	0
1	BS# 22	Full	2018-06-11	14:56	60° 25,415'	94° 00,173'	CTD Rosette ↓	60,51	142	0,8	5,8	1,167	1002,02	81	0
1	BS# 22	Full	2018-06-11	15:02	60° 25,470'	94° 00,172'	Helicopter ↑	59,42	108	6,5	5,6	1,145	1002,25	83	0
1	BS# 22	Full	2018-06-11	16:05	60° 25,300'	94° 00,382'	Zodiac ↓	59,86	91	8,6	4,1	0,948	1001,8	87	0
1	BS# 22	Full	2018-06-11	16:31	60° 25,401'	94° 00,571'	Optics IOP ↓	59,07	71	10,5	4,1	0,935	1001,49	88	0
1	BS# 22	Full	2018-06-11	17:34	60° 25,732'	94° 00,442'	Optics IOP ↑	47,16	92	12	4,6	2,017	1001,37	91	0

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1	BS# 22	Full	2018-06-11	17:47	60° 25,075'	94° 00,376'	Box core ↓	62,81	91	13,7	5,9	2,537	1001,44	93	0
1	BS# 22	Full	2018-06-11	17:49	60° 25,075'	94° 00,371'	Box core (bottom)	62,8	83	9,5	8,4	1,549	1001,45	75	0
1	BS# 22	Full	2018-06-11	17:53	60° 25,093'	94° 00,376'	Box core ↑	62,55	80	9,3	9	0,905	1001,26	78	0
1	BS# 22	Full	2018-06-11	18:08	60° 25,142'	94° 00,606'	Box core ↓	60,67	87	14,1	7,5	0,997	1001,28	78	0
1	BS# 22	Full	2018-06-11	18:10	60° 25,145'	94° 00,608'	Box core (bottom)	60,78	91	13,1	5,6	1,3	1001,33	91	0
1	BS# 22	Full	2018-06-11	18:14	60° 25,159'	94° 00,629'	Box core ↑	59,38	91	12,2	5,2	0,828	1001,38	94	0
1	BS# 22	Full	2018-06-11	18:29	60° 25,154'	94° 01,281'	Agassis trawl ↓	63	95	9,3	4,2	2,699	1001,49	96	0
1	BS# 22	Full	2018-06-11	18:40	60° 25,012'	94° 01,765'	Agassis trawl ↑	65,27	95	10,1	4,2	2,932	1001,56	97	0
1	BS# 22	Full	2018-06-11	19:11	60° 24,787'	94° 02,699'	Helicopter ↑	56,2	91	10,7	4,3	3,066	1001,31	98	0
1	BS# 22	Full	2018-06-11	19:40	60° 25,081'	94° 00,636'	Beam Trawl ↓	64,47	98	14,5	4,2	3,195	1001,26	98	0
1	BS# 22	Full	2018-06-11	20:03	60° 25,476'	94° 00,321'	Beam Trawl ↑	59,02	52	7,6	4,9	3,347	1001,15	98	0
1	BS# 22	Full	2018-06-11	20:30	60° 25,666'	94° 01,202'	Zodiac ↑	57,17	96	12,8	4,4	2,934	1001,11	98	0
1	BS# 23	Nutrient	2018-06-12	3:20	60° 55,326'	91° 46,853'	CTD Rosette ↓	110,52	107	21,3	1,7	0,204	1005,38	91	0
1	BS# 23	Nutrient	2018-06-12	3:51	60° 55,442'	91° 47,114'	CTD Rosette ↑	111,52	102	15,4	4,3	0,202	1005,07	86	
1	BS# 23	Nutrient	2018-06-12	4:02	60° 55,524'	91° 47,421'	Agassis trawl ↓	110,82	107	23,2	2	0,177	1005,16	90	
1	BS# 23	Nutrient	2018-06-12	4:13	60° 55,615'	91° 48,131'	Agassis trawl ↑	109,19	96	19	1,4	0,229	1005,15	92	
1	BS# 24	Ice	2018-06-12	14:14	61° 39,892'	88° 02,529'	Helicopter ↓	175,3	110	24,9	0,2	-0,857	1016,25	85	9
1	BS# 24	Ice	2018-06-12	15:34	61° 39,888'	87° 42,696'	ice team cage ↓	185	237	1	1	-1,533	1017,36	83	10
1	BS# 24	Ice	2018-06-12	17:36	61° 41,423'	87° 44,695'	Helicopter ↑		136	1,7	2,1	-1,419	1017,71	80	9
1	BS# 24	Ice	2018-06-12	17:46	61° 41,546'	87° 44,890'	Ice team ↑		133	2,7	2,3	-1,391	1017,84	80	10
1	BS# 24	Ice	2018-06-12	18:12	61° 41,704'	87° 45,411'	Helicopter ↓		113	19,6	0,6	-1,258	1018,08	86	10
1	BS# 24	Ice	2018-06-12	18:19	61° 41,692'	87° 45,589'	PNF ↓	188,34	112	17,9	1	-1,311	1018,29	84	10
1	BS# 24	Ice	2018-06-12	18:22	61° 41,713'	87° 45,612'	PNF ↑	188,84	113	20,8	0,5	-1,367	1018,25	85	10
1	BS# 24	Ice	2018-06-12	18:31	61° 41,759'	87° 45,707'	CTD Rosette ↓	189,39	75	8,6	2,6	-1,37	1018,42	80	10
1	BS# 24	Ice	2018-06-12	19:00	61° 41,990'	87° 46,372'	CTD Rosette ↑	189,06	115	13,3	3,4	-1,303	1018,83	76	10
1	BS# 24	Ice	2018-06-12	19:10	61° 42,104'	87° 46,596'	Optics IOP ↓	189,29	106	16,8	1,9	-1,276	1018,69	84	10
1	BS# 24	Ice	2018-06-12	19:43	61° 42,366'	87° 46,962'	Optics IOP ↑	189,07	112	10,9	1,5	-1,243	1019,73	84	10
1	BS# 24	Ice	2018-06-12	20:03	61° 42,498'	87° 47,209'	Helicopter ↑	190,22	122	10,9	0,7	-1,232	1020,2	87	10
1	BS# 24	Ice	2018-06-12	20:24	61° 42,652'	87° 47,710'	Optics Lisst ↓		118	10,7	0,5	-1,214	1020,55	88	10
1	BS# 24	Ice	2018-06-12	20:36	61° 42,744'	87° 47,738'	Optics Lisst ↑		118	9,5	0,4	-1,226	1020,68	89	10
1	BS# 24	Ice	2018-06-12	20:43	61° 42,784'	87° 47,642'	Optics IOP ↓	188	120	10,5	0,4	-1,234	1020,7	89	10
1	BS# 24	Ice	2018-06-12	21:17	61° 42,933'	87° 47,115'	Optics IOP ↑	188,71	108	11,8	0,2	-1,232	1020,5	90	10
1	BS# 24	Ice	2018-06-12	21:32	61° 42,919'	87° 47,326'	Hydrobios ↓	188,52	108	12,2	1,1	-1,215	1020,7	88	10
1	BS# 24	Ice	2018-06-12	21:43	61° 42,907'	87° 47,362'	Hydrobios ↑	190,59	110	10,1	0,3	-1,192	1020,72	90	10
1	BS# 24	Ice	2018-06-12	22:14	61° 42,664'	87° 47,629'	Monster net ↓	189,57	76	6,9	2,7	-1,128	1020,9	80	10
1	BS# 24	Ice	2018-06-12	22:25	61° 42,586'	87° 47,676'	Monster Net ↑	189,66	106	16,9	1,1	-1,2	1020,88	88	10
1	BS# 24	Ice	2018-06-12	22:43	61° 42,649'	87° 47,271'	CTD Rosette ↓	188,81	66	8,6	1,3	-1,155	1021,19	86	10
1	BS# 24	Ice	2018-06-12	23:23	61° 42,416'	87° 47,437'	CTD Rosette ↑	189,82	96	6,5	1	-1,142	1020,89	88	10
1	BS# 24	Ice	2018-06-12	23:37	61° 42,489'	87° 46,895'	Box core ↓	188,5	103	16	0	-1,126	1020,93	90	10
1	BS# 24	Ice	2018-06-12	23:41	61° 42,469'	87° 46,903'	Box core (bottom)	188,28	108	14,5	1,7	-1,119	1020,93	90	10
1	BS# 24	Ice	2018-06-12	23:45	61° 42,446'	87° 46,938'	Box core ↑	188,36	94	11,2	3,4	-1,114	1021,04	76	10
1	BS# 24	Ice	2018-06-13	0:00	61° 42,359'	87° 47,066'	Box core ↓		101	17,9	1	-1,101	1021,05	88	10
1	BS# 24	Ice	2018-06-13	0:04	61° 42,328'	87° 47,069'	Box core (bottom)		104	17,5	0,1	-1,087	1021,15	89	10
1	BS# 24	Ice	2018-06-13	0:08	61° 42,304'	87° 47,077'	Box core ↑		104	16,6	0,3	-1,087	1021,16	89	10
1	BS# 25	Full	2018-06-13	5:12	62° 00,850'	86° 59,718'	Tucker net ↓		67	6,3	-1,7	2,71	1022,77	94	7
1	BS# 25	Full	2018-06-13	5:25	62° 00,631'	86° 59,412'	Tucker net ↑	150	93	7,6	-1,7	1,663	1022,88	94	7
1	BS# 25	Full	2018-06-13	5:47	62° 00,663'	86° 59,562'	Hydrobios ↑	150	64	6,7	-1,9	-1,288	1022,96	95	7
1	BS# 25	Full	2018-06-13	5:47	62° 00,663'	86° 59,562'	Hydrobios ↓	150	64	6,7	-1,9	-1,288	1022,96	95	7
1	BS# 25	Full	2018-06-13	6:26	62° 01,075'	87° 00,257'	Monster net ↓	149,22	61	8	-2,2	-1,299	1022,89	96	7
1	BS# 25	Full	2018-06-13	6:36	62° 01,118'	87° 00,420'	Monster net ↑	149,76	39	7	-2,5	-1,315	1022,9	96	7
1	BS# 25	Full	2018-06-13	6:58	62° 01,307'	87° 00,516'	CTD Rosette ↓	148,19	12	3,6	-1,4	-1,252	1023,07	92	7
1	BS# 25	Full	2018-06-13	7:28	62° 01,345'	87° 00,989'	CTD Rosette ↑	145,58	70	4	-1	-1,327	1022,9	90	7

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1	BS# 25	Full	2018-06-13	7:52	62° 01,471'	87° 00,667'	Box core ↓	143,2	90	9,9	-1,9	-1,285	1023,04	94	7
1	BS# 25	Full	2018-06-13	7:55	62° 01,475'	87° 00,671'	Box core (bottom)	143,25	93	11,4	-2,6	-1,292	1023,04	94	7
1	BS# 25	Full	2018-06-13	7:58	62° 01,481'	87° 00,692'	Box core ↑	143,42	93	10,5	-2,4	-1,28	1022,97	94	7
1	BS# 25	Full	2018-06-13	8:10	62° 01,443'	87° 00,595'	Agassis trawl ↓	144,61	98	8,8	-2,4	-1,292	1022,9	93	7
1	BS# 25	Full	2018-06-13	8:20	62° 01,436'	87° 01,134'	Agassis trawl ↑	144,56	87	8,6	-2,5	-1,349	1022,83	94	7
1	BS# 25	Full	2018-06-13	12:22	62° 00,403'	86° 59,884'	Skippy boat ↓	150,74	62	6,5	-1,6	-1,25	1023,74	92	7
1	BS# 25	Full	2018-06-13	12:59	62° 00,301'	86° 59,170'	PNF ↓	150,52	83	4	-1,1	-1,28	1023,67	91	7
1	BS# 25	Full	2018-06-13	13:04	62° 00,295'	86° 59,087'	PNF ↑	151,67	93	3,8	-1,1	-1,251	1023,73	91	7
1	BS# 25	Full	2018-06-13	13:18	62° 00,243'	86° 58,913'	CTD Rosette ↓	150,46	76	1,7	0,7	-1,284	1023,61	85	7
1	BS# 25	Full	2018-06-13	13:48	62° 00,191'	86° 58,728'	CTD Rosette ↑	151,16	67	5,7	-0,7	-1,281	1023,42	92	7
1	BS# 25	Full	2018-06-13	14:36	61° 59,986'	86° 58,317'	Ice team ↑	150	72	4,6	-0,1	-1,196	1023,47	92	7
1	BS# 25	Full	2018-06-13	15:27	62° 00,105'	86° 58,172'	Skippy boat ↑	152,69	36	6,7	-0,3	-1,175	1023,08	93	7
1	BS# 25	Full	2018-06-13	16:49	62° 00,200'	86° 59,014'	Helicopter ↓	152,5	31	6,5	0,1	-0,774	1022,96	92	7
1	BS# 25	Full	2018-06-13	16:58	62° 00,308'	86° 59,314'	Optics IOP ↓	150	48	6,3	0,4	-0,887	1022,94	91	7
1	BS# 25	Full	2018-06-13	17:29	62° 00,476'	86° 59,718'	Optics IOP ↑	150	41	3,6	1	-1	1023,02	84	7
1	BS# 25	Full	2018-06-13	17:31	62° 00,494'	86° 59,753'	Optics Lisst ↓	150	53	4,4	1,4	-1,018	1022,96	85	7
1	BS# 25	Full	2018-06-13	17:43	62° 00,560'	86° 59,915'	Optics Lisst ↑	150,61	25	1	2,9	-0,959	1022,81	80	7
1	BS# 25	Full	2018-06-13	18:07	62° 00,585'	87° 00,359'	Helicopter ↑	150,39	29	5	0,2	-0,915	1022,66	91	7
1	BS# 25	Full	2018-06-13	18:25	62° 00,640'	87° 00,658'	Optics IOP ↓	149,99	47	7,8	0	-0,82	1022,39	92	7
1	BS# 25	Full	2018-06-13	18:52	62° 00,982'	87° 00,998'	Optics IOP ↑	149,25	34	6,1	0,1	-1,019	1022,47	91	7
1	BS# 26	Nutrient	2018-06-14	1:43	62° 12,325'	88° 22,174'	UpTempo ↓	130,44	106	3	1,4	0,861	1021,85	88	0
1	BS# 26	Nutrient	2018-06-14	1:57	62° 12,252'	88° 22,652'	CTD Rosette ↓	131,46	128	1,7	2	1,183	1021,8	86	0
1	BS# 26	Nutrient	2018-06-14	2:24	62° 12,051'	88° 22,636'	CTD Rosette ↑	134,1	75	3,4	1,3	1,164	1021,6	88	0
1			2018-06-14	2:35	62° 12,106'	88° 23,424'	MVP ↓	131,86	40	2,1	2,2	1,299	1021,39	86	0
1			2018-06-14	11:55	62° 34,887'	90° 54,676'	MVP ↑	67,46	333	3,6	1	0,615	1019,54	93	
1	BS# 27	Nutrient	2018-06-14	12:08	62° 35,016'	90° 55,367'	CTD Rosette ↓	61,02	78	2,5	1,6	0,806	1019,38	91	0
1	BS# 27	Nutrient	2018-06-14	12:30	62° 34,888'	90° 55,379'	CTD Rosette ↑	63,08	18	1,1	2,5	0,807	1019,35	84	0
1	BS# 28	Nutrient	2018-06-15	1:17	62° 24,964'	89° 50,077'	Water Sampling ↓	162,91	232	9,3	3,6	2,304	1015,62	91	0
1	BS# 28	Nutrient	2018-06-15	1:19	62° 24,931'	89° 50,035'	CTD Rosette ↓	163,63	250	8,2	3,5	1,996	1015,64	91	0
1	BS# 28	Nutrient	2018-06-15	1:38	62° 24,783'	89° 49,776'	Water Sampling ↑	162,8	221	6,7	4,7	2,488	1015,67	84	0
1	BS# 28	Nutrient	2018-06-15	1:54	62° 24,715'	89° 49,605'	CTD Rosette ↑	162,57	241	6,5	5	2,183	1015,58	83	0
1	BS# 28	Nutrient	2018-06-15	2:09	62° 24,876'	89° 49,195'	Tucker Net ↓	162,55	235	7,2	3,7	2,763	1015,34	88	0
1	BS# 28	Nutrient	2018-06-15	2:25	62° 25,086'	89° 50,104'	Tucker Net ↑	162,52	244	11,8	3,5	2,914	1015,32	86	0
1	BS# 28	Nutrient	2018-06-15	2:43	62° 24,930'	89° 49,772'	Monster Net ↓	161,98	228	7,8	3,5	1,992	1015,36	88	0
1	BS# 28	Nutrient	2018-06-15	2:53	62° 24,918'	89° 49,533'	Monster Net ↑	161,96	232	7,6	3,2	1,654	1015,42	89	0
1	BS# 28	Nutrient	2018-06-15	3:14	62° 24,870'	89° 49,027'	Agassis trawl ↓	162,2	249	7	3,2	2,361	1015,24	90	0
1	BS# 28	Nutrient	2018-06-15	3:27	62° 24,833'	89° 49,314'	Agassis trawl ↑	161,99	190	3,8	3,3	2,809	1015,26	91	0
1	BS# 28	Nutrient	2018-06-15	3:45	62° 24,967'	89° 49,193'	Box core ↓	161,79	247	9,3	3	2,489	1015,45	92	0
1	BS# 28	Nutrient	2018-06-15	3:49	62° 24,984'	89° 49,183'	Box core (bottom)	161,74	253	8,8	3,1	2,583	1015,4	92	0
1	BS# 28	Nutrient	2018-06-15	3:52	62° 24,996'	89° 49,165'	Box core ↑		253	8,6	3	2,606	1015,43	92	0
1	BS# 28	Nutrient	2018-06-15	4:05	62° 25,010'	89° 49,101'	Box core ↓	161,75	247	8,4	2,7	1,303	1015,51	92	0
1	BS# 28	Nutrient	2018-06-15	4:10	62° 25,005'	89° 49,049'	Box core (bottom)	161,79	241	7,6	2,9	1,285	1015,56	92	0
1	BS# 28	Nutrient	2018-06-15	4:13	62° 24,997'	89° 49,026'	Box core ↑	161,76	249	8,6	2,8	1,266	1015,54	93	0
1	BS# 28	Nutrient	2018-06-15	4:25	62° 24,991'	89° 49,276'	Beam trawl ↓	161,71	258	6,3	3	2,086	1015,65	92	0
1	BS# 28	Nutrient	2018-06-15	4:52	62° 25,933'	89° 49,119'	Beam trawl ↑	162,59	266	9,9	2,6	2,422	1015,38	94	0
1	BS# 29	Full	2018-06-16	8:01	61° 44,526'	84° 16,208'	Tucker net ↓	179,93	45	1,5	-0,1	4,075	1011,18	90	10
1	BS# 29	Full	2018-06-16	8:11	61° 44,762'	84° 16,640'	Tucker Net ↑		120	6,5	0,8	2,706	1011,02	87	10
1	BS# 29	Full	2018-06-16	8:30	61° 44,688'	84° 16,780'	Monster Net ↓	180,2	109	2,5	0,6	1,392	1010,98	87	10
1	BS# 29	Full	2018-06-16	8:41	61° 44,740'	84° 17,010'	Monster Net ↑	180,65	125	6,7	-0,4	1,21	1011,04	91	10
1	BS# 29	Full	2018-06-16	8:59	61° 44,760'	84° 17,110'	Agassis trawl ↓	180,27	113	6,1	-0,4	1,045	1011,13	91	10
1	BS# 29	Full	2018-06-16	9:15	61° 45,175'	84° 17,926'	Agassis trawl ↑	179,79	109	4,6	0,4	0,963	1010,95	89	10
1	BS# 29	Full	2018-06-16	9:31	61° 44,814'	84° 17,551'	Box core ↓	179,6	134	5,1	-0,1	0,85	1010,85	91	10

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1	BS# 29	Full	2018-06-16	9:34	61° 44,821'	84° 17,584'	Box core (bottom)	179,37	122	5,5	-0,2	0,814	1010,87	90	10
1	BS# 29	Full	2018-06-16	9:42	61° 44,817'	84° 17,697'	Box core ↑	179,47	126	5,1	0,8	0,775	1010,89	88	10
1	BS# 29	Full	2018-06-16	9:54	61° 44,923'	84° 17,718'	Box core ↓	177,93	121	6,1	2,2	0,773	1010,92	91	10
1	BS# 29	Full	2018-06-16	9:58	61° 44,920'	84° 17,745'	Box core (bottom)	177,46	136	5	1,8	0,744	1010,92	85	10
1	BS# 29	Full	2018-06-16	10:05	61° 44,929'	84° 17,848'	Box core ↑	177,94	126	3	1,2	0,724	1010,93	87	10
1	BS# 29	Full	2018-06-16	10:26	61° 44,973'	84° 17,849'	Beam Trawl ↓	178,57	88	3,2	1,2	0,752	1010,78	88	10
1	BS# 29	Full	2018-06-16	10:50	61° 45,428'	84° 19,105'	Beam Trawl ↑	178,94	143	6,3	0,3	0,632	1011,11	93	10
1	BS# 29	Full	2018-06-16	12:18	61° 45,613'	84° 18,172'	Mooring ↓	178,81	103	8,4	0,1	-1,43	1010,76	93	
1	BS# 29	Full	2018-06-16	13:05	61° 46,186'	84° 18,546'	CTD Rosette ↓	176,99	125	8,4	0	-1,472	1011	96	
1	BS# 29	Full	2018-06-16	13:44	61° 46,047'	84° 17,875'	CTD Rosette ↑	178,31	85	4,4	1,4	-1,468	1010,75	93	9
1	BS# 31	Nutrient	2018-06-18	13:32	57° 42,495'	91° 33,550'	Helicopter ↓	55,26	219	20,9	4,4	20,9	1012,59	96	2
1	BS# 31	Nutrient	2018-06-18	15:07	57° 29,799'	91° 48,427'	Water Sampling ↓	44,02	232	12,4	8	12,4	1013,02	94	2
1	BS# 31	Nutrient	2018-06-18	15:42	57° 30,018'	91° 48,417'	Water Sampling ↑	43,21	214	12,9	8,9	12,9	1012,8	92	2
1	BS# 31	Nutrient	2018-06-18	17:03	57° 29,806'	91° 48,377'	Mooring ↑	46,05	200	14,5	11,9	14,5	1012,43	81	2
1	BS# 31	Nutrient	2018-06-18	17:51	57° 29,305'	91° 49,632'	Helicopter ↓	45,29	211	13,9	12,1	13,9	1012,23	83	2
1	BS# 31	Nutrient	2018-06-18	18:19	57° 30,005'	91° 47,719'	CTD Rosette ↓	47,4	193	11,6	12,1	11,6	1012,02	82	2
1	BS# 31	Nutrient	2018-06-18	18:39	57° 30,020'	91° 48,031'	CTD Rosette ↑	46,42	181	13,3	12,2	13,3	1011,64	78	2
1	BS# 32	Ice	2018-06-19	12:35	56° 57,958'	88° 05,715'	Ice cage ↓	30,5	353	15,6	1	-1,531	1010,59	99	5
1	BS# 32	Ice	2018-06-19	13:38	56° 57,625'	88° 06,165'	Ice cage ↑	33,42	337	18,1	0,5	-1,141	1011,29	98	5
1	BS# 32	Ice	2018-06-19	14:20	56° 57,823'	88° 07,042'	Zodiac ↓	37,02	324	13,1	0,6	-1,563	1012,41	98	5
1	BS# 32	Ice	2018-06-19	14:39	56° 57,918'	88° 07,312'	Zodiac ↑	34,03	14	2,9	2	-1,397	1012,62	95	5
1	BS# 32	Ice	2018-06-19	16:28	56° 59,021'	88° 06,679'	PNF ↑	33,06	34	2,9	2,3	-0,966	1013,87	85	5
1	BS# 32	Ice	2018-06-19	16:42	56° 59,041'	88° 06,947'	CTD Rosette ↓	32,97	22	0,8	2,5	-1,167	1014,05	84	5
1	BS# 32	Ice	2018-06-19	17:02	56° 59,155'	88° 07,298'	CTD Rosette ↑	32,52	327	10,3	3,7	-1,336	1014,39	81	5
1	BS# 32	Ice	2018-06-19	17:15	56° 59,184'	88° 07,728'	Helicopter ↑	33,09	307	13,3	1,1	-1,122	1014,4	89	5
1	BS# 32	Ice	2018-06-19	17:38	56° 59,264'	88° 07,985'	Monster net ↓	32,18	309	10,3	1,3	-1,304	1014,76	89	5
1	BS# 32	Ice	2018-06-19	17:41	56° 59,272'	88° 08,027'	Monster net ↑	32,32	311	10,9	1,1	-1,299	1014,81	89	5
1	BS# 32	Ice	2018-06-19	17:53	56° 59,235'	88° 08,334'	Zodiac ↑	32,12	307	10,5	1,1	-1,097	1014,82	88	5
1	BS# 32	Ice	2018-06-19	18:05	56° 59,256'	88° 08,426'	Helicopter ↓	32,5	310	7,4	1,3	-1,405	1014,92	89	5
1	BS# 32	Ice	2018-06-19	18:22	56° 59,137'	88° 08,565'	Optics IOP ↓	33,14	298	8	1,1	-1,34	1014,98	90	5
1	BS# 32	Ice	2018-06-19	18:34	56° 59,136'	88° 08,596'	Optics IOP ↑	33,4	302	10,3	1,2	-1,292	1015,18	91	5
1	BS# 32	Ice	2018-06-19	18:37	56° 59,135'	88° 08,601'	Optics Lisst ↓	33,44	289	10,3	1,1	-1,284	1015,14	91	5
1	BS# 32	Ice	2018-06-19	18:43	56° 59,130'	88° 08,608'	Optics Lisst ↑	33,46	285	9,1	1	-1,243	1015,27	91	5
1	BS# 32	Ice	2018-06-19	18:59	56° 59,111'	88° 09,162'	Optics IOP ↓	33,9	318	12,8	1,3	-0,697	1015,34	91	5
1	BS# 32	Ice	2018-06-19	19:18	56° 58,974'	88° 08,872'	Optics IOP ↑	34,02	305	11	1,1	-1,082	1015,65	91	5
1	BS# 32	Ice	2018-06-19	19:26	56° 58,921'	88° 08,809'	CTD Rosette ↓	35,03	306	10,9	1,2	-0,697	1015,72	91	5
1	BS# 32	Ice	2018-06-19	19:44	56° 58,760'	88° 08,623'	CTD Rosette ↑	34,2	312	12,9	1,2	-1,086	1015,72	91	5
1	BS# 32	Ice	2018-06-19	20:19	56° 58,522'	88° 08,169'	Helicopter ↑	34,57	325	15,2	1,5	-1,152	1015,97	90	5
1	BS# 32	Ice	2018-06-19	20:36	56° 58,427'	88° 08,199'	Box core ↓	33,35	303	11,4	1,9	-1,155	1016,04	89	5
1	BS# 32	Ice	2018-06-19	20:38	56° 58,427'	88° 08,194'	Box core (bottom)	33,47	315	12,4	1,8	-1,205	1016	90	5
1	BS# 32	Ice	2018-06-19	20:42	56° 58,427'	88° 08,194'	Box core ↑	33,47	315	12,4	1,8	-1,205	1016	90	5
1	BS# 32	Ice	2018-06-19	20:44	56° 58,423'	88° 08,141'	Box core ↓	34,05	324	14,3	1,9	-1,141	1015,91	88	5
1	BS# 32	Ice	2018-06-19	20:46	56° 58,421'	88° 08,134'	Box core (bottom)	34,29	324	12,4	1,6	-1,121	1015,97	89	5
1	BS# 32	Ice	2018-06-19	20:48	56° 58,411'	88° 08,115'	Box core ↑	34,41	316	11,6	1,2	-1,307	1015,98	90	5
1	BS# 32	Ice	2018-06-19	20:59	56° 58,274'	88° 07,825'	Box core ↓	33,64	316	12	3	-1,248	1015,97	82	5
1	BS# 32	Ice	2018-06-19	21:01	56° 58,276'	88° 07,807'	Box core (bottom)	33,6	295	10,1	3	-1,232	1015,98	87	5
1	BS# 32	Ice	2018-06-19	21:03	56° 58,271'	88° 07,761'	Box core ↑	34,19	32	2,7	2,8	-1,126	1016	82	5
1	BS# 32	Ice	2018-06-19	21:28	56° 57,120'	88° 07,330'	Agassis trawl ↓	31,88	308	9,7	1,5	-1,204	1016,15	90	5
1	BS# 32	Ice	2018-06-19	21:33	56° 57,130'	88° 07,064'	Agassis trawl ↑	34,26	311	7,8	1,3	-0,816	1016,18	90	5
1	BS# 33	Ice	2018-06-20	12:55	56° 36,684'	87° 05,423'	Ice cage ↓	47,49	291	5,1	0,4	5,1	1017,46	90	9
1	BS# 33	Ice	2018-06-20	13:50	56° 36,619'	87° 04,766'	Ice cage ↑	47,19	292	2,9	1,3	2,9	1017,44	88	9
1	BS# 33	Ice	2018-06-20	14:24	56° 36,052'	87° 03,950'	Ice team ↓	49,46	301	4,2	1,5	4,2	1017,17	86	9

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1	BS# 33	Ice	2018-06-20	14:29	56° 36,071'	87° 03,917'	Ice team ↑	49,37	333	3,4	2,2	3,4	1017,12	82	9
1	BS# 34	Full	2018-06-20	22:02	56° 30,407'	86° 53,533'	PNF ↓	45,17	117	8,6	2,4	-0,522	1015,22	88	2
1	BS# 34	Full	2018-06-20	22:04	56° 30,370'	86° 53,653'	Zodiac ↓	46,46	337	1	3,7	-0,4	1015,18	83	2
1	BS# 34	Full	2018-06-20	22:05	56° 30,402'	86° 53,590'	PNF ↑	46,03	116	8	2,4	0,376	1015,16	87	2
1	BS# 34	Full	2018-06-20	22:19	56° 30,364'	86° 53,653'	CTD Rosette ↓		164	6,7	3,6	-1,088	1015,12	85	2
1	BS# 34	Full	2018-06-20	22:38	56° 30,319'	86° 53,671'	CTD Rosette ↑	45,87	201	1,3	3,4	-0,358	1014,9	82	2
1	BS# 34	Full	2018-06-20	22:50	56° 30,372'	86° 53,479'	Optics IOP ↓	45,81	219	2,3	3,3	0,241	1014,51	86	2
1	BS# 34	Full	2018-06-20	23:14	56° 30,215'	86° 53,677'	Optics IOP ↑	47,11	153	8,6	3	0,122	1014,62	85	2
1	BS# 34	Full	2018-06-20	23:25	56° 30,259'	86° 53,062'	Optics IOP ↓	43,24	127	6,9	2,8	-0,307	1014,54	86	2
1	BS# 34	Full	2018-06-20	23:40	56° 30,260'	86° 52,938'	Optics IOP ↑	42,88	137	7,8	2,6	0,116	1014,42	85	2
1	BS# 34	Full	2018-06-20	23:43	56° 30,263'	86° 52,902'	Optics Lisst ↓	41,8	137	8	2,6	-0,878	1014,38	85	2
1	BS# 34	Full	2018-06-20	23:49	56° 30,286'	86° 52,860'	Optics Lisst ↑	45,04	132	8	2,6	-0,801	1014,31	85	2
1	BS# 34	Full	2018-06-21	0:00	56° 30,125'	86° 52,738'	Zodiac ↑	42,36	141	10,5	2,5	0,249	1014,04	86	2
1	BS# 34	Full	2018-06-21	0:23	56° 30,126'	86° 52,558'	Tucker Net ↓	43,73	142	8,6	2,4	1,147	1014,1	87	2
1	BS# 34	Full	2018-06-21	0:33	56° 29,817'	86° 52,600'	Tucker Net ↑	44,01	160	12,2	2,6	0,807	1014,01	88	2
1	BS# 34	Full	2018-06-21	0:50	56° 29,847'	86° 52,312'	Monster Net ↓	44,69	129	10,1	2,3	-0,648	1013,76	86	2
1	BS# 34	Full	2018-06-21	0:56	56° 29,881'	86° 52,243'	Monster Net ↑	44,22	129	9,3	2,4	-0,429	1013,85	86	2
1	BS# 34	Full	2018-06-21	1:09	56° 29,989'	86° 52,125'	CTD Rosette ↓	43,78	160	8,8	5,5	-0,252	1013,83	74	2
1	BS# 34	Full	2018-06-21	1:28	56° 30,007'	86° 51,765'	CTD Rosette ↑	41,35	153	10,9	3,5	-0,428	1013,73	84	2
1	BS# 34	Full	2018-06-21	1:45	56° 30,218'	86° 51,157'	Agassis trawl ↓	35,72	146	10,1	2,5	1,307	1013,49	86	2
1	BS# 34	Full	2018-06-21	1:52	56° 30,231'	86° 51,381'	Agassis trawl ↑	37,03	143	10,3	2,3	0,822	1013,54	86	2
1	BS# 34	Full	2018-06-21	2:08	56° 30,348'	86° 51,194'	Box core ↓	37,41	163	9,9	4,2	-0,172	1013,44	79	2
1	BS# 34	Full	2018-06-21	2:10	56° 30,353'	86° 51,170'	Box core (bottom)	36,87	162	8,6	5,9	-0,366	1013,4	71	2
1	BS# 34	Full	2018-06-21	2:12	56° 30,356'	86° 51,150'	Box core ↑	37,03	163	10,5	5,7	-0,426	1013,37	75	2
1	BS# 34	Full	2018-06-21	12:42	56° 32,695'	86° 49,296'	Helicopter ↓	43,17	183	5,9	5,4	-0,96	1007,72	85	4
1	BS# 34	Full	2018-06-21	12:58	56° 32,587'	86° 48,976'	Ice Cage ↓	43,09	210	5	5,7	-0,763	1007,58	81	4
1	BS# 34	Full	2018-06-21	13:16	56° 32,494'	86° 48,604'	Zodiac ↓	41,59	151	3	6,2	-0,611	1007,17	76	4
1	BS# 34	Full	2018-06-21	14:30	56° 32,345'	86° 47,036'	Ice cage ↑	43,32	229	12,4	4,2	-0,876	1005,83	88	4
1	BS# 34	Full	2018-06-21	14:43	56° 32,212'	86° 46,850'	Zodiac ↑	42,66	241	8,2	4,7	-0,342	1005,73	86	4
1	BS# 34	Full	2018-06-21	15:12	56° 32,538'	86° 46,342'	Helicopter ↑	47,45	225	12	7,3	-1,289	1005,29	75	5
1	BS# 34	Full	2018-06-21	16:22	56° 32,638'	86° 45,306'	Ice Cage ↓	46,87	267	10,7	6,6	-1,317	1005,52	77	5
1	BS# 34	Full	2018-06-21	17:05	56° 32,730'	86° 44,974'	Ice cage ↑	47,52	291	9,5	6,2	-1,335	1006,05	80	5
1	BS# 34	Full	2018-06-21	18:29	56° 34,659'	86° 44,452'	Helicopter ↓	45,64	333	15,4	2,5	-1,507	1006,66	94	5
1	BS# 34	Full	2018-06-21	18:37	56° 34,981'	86° 44,438'	Helicopter ↑	47,37	310	11	2,4	-1,511	1007,03	94	5
1	BS# 35	Nutrient	2018-06-22	2:40	57° 10,801'	86° 30,023'	Water Sampling ↓	62,01	322	10,5	-0,3	10,5	1012,45	99	8
1	BS# 35	Nutrient	2018-06-22	2:42	57° 10,786'	86° 29,996'	CTD Rosette ↓	61,46	323	9,3	-0,3	9,3	1012,43	99	8
1	BS# 35	Nutrient	2018-06-22	3:02	57° 10,760'	86° 29,903'	CTD Rosette ↑	62,51	264	1,1	0,2	-1,451	1012,26	98	8
1	BS# 35	Nutrient	2018-06-22	3:08	57° 10,757'	86° 29,880'	Water Sampling ↑	62,54	331	1,3	0,3	-1,451	1012,28	98	8
1	BS# 36	Basic	2018-06-22	11:26	57° 47,779'	86° 03,514'	Hydrobios ↓	129,47	270	9,9	0,5	-1,543	1011,79	92	8
1	BS# 36	Basic	2018-06-22	11:36	57° 47,703'	86° 03,433'	Hydrobios ↑	129,11	269	11,6	0,5	-1,584	1011,81	92	8
1	BS# 36	Basic	2018-06-22	12:45	57° 47,223'	86° 02,629'	Helicopter ↓	130,52	295	13,5	1	-1,259	1012,1	91	8
1	BS# 36	Basic	2018-06-22	13:19	57° 46,912'	86° 02,719'	Skippy boat ↓	126,05	279	11,6	0,8	-1,559	1012,24	91	8
1	BS# 36	Basic	2018-06-22	13:36	57° 46,792'	86° 02,651'	Ice Team ↓	129,5	333	3,2	2,1	-1,587	1012,3	86	8
1	BS# 36	Basic	2018-06-22	14:04	57° 46,677'	86° 02,279'	Vertical Net ↓	127,66	264	11,4	0,6	-1,594	1012,39	92	8
1	BS# 36	Basic	2018-06-22	14:13	57° 46,606'	86° 02,197'	Vertical Net ↑	125,08	271	10,7	0,6	-1,559	1012,4	92	8
1	BS# 36	Basic	2018-06-22	14:13	57° 46,606'	86° 02,197'	Helicopter ↑	125,08	271	10,7	0,6	-1,559	1012,4	92	8
1	BS# 36	Basic	2018-06-22	14:38	57° 46,602'	86° 01,975'	PNF ↑	128,36	275	8,9	4,2	-1,596	1012,57	73	
1	BS# 36	Basic	2018-06-22	15:19	57° 46,447'	86° 01,878'	CTD Rosette ↓	128,34	277	11,2	1,7	-1,566	1012,51	89	8
1	BS# 36	Basic	2018-06-22	15:52	57° 46,401'	86° 01,629'	CTD Rosette ↑	128,36	303	4,4	2,8	-1,574	1012,45	83	8
1	BS# 36	Basic	2018-06-22	16:15	57° 46,296'	86° 01,392'	Ice Team ↑	125,55	295	11,6	1,5	-1,557	1012,18	87	8
1	BS# 36	Basic	2018-06-22	16:24	57° 46,292'	86° 01,332'	Skippy boat ↑	127,75	304	13,1	1,7	-1,535	1012,23	86	8
1	BS# 36	Basic	2018-06-22	17:38	57° 46,324'	86° 01,300'	Helicopter ↓	127,35	286	13,1	1,4	-1,553	1012,29	89	8

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1	BS# 36	Basic	2018-06-22	17:57	57° 46,503'	86° 01,559'	CTD Rosette ↓	127,5	293	13,1	1,4		1012,6	89	8
1	BS# 36	Basic	2018-06-22	18:22	57° 46,526'	86° 01,505'	CTD Rosette ↑	127,64	300	1,5	2,1	-1,579	1012,64	85	8
1	BS# 36	Basic	2018-06-22	18:34	57° 46,528'	86° 01,584'	Optics IOP ↓	127,03	276	10,3	1,3	-1,575	1012,71	88	8
1	BS# 36	Basic	2018-06-22	19:00	57° 46,542'	86° 01,561'	Optics IOP ↑	127,23	273	10,3	1,1	-1,524	1012,66	89	8
1	BS# 36	Basic	2018-06-22	19:02	57° 46,545'	86° 01,565'	Optics Lisst ↓	127,22	271	10,7	1,2	-1,563	1012,65	89	8
1	BS# 36	Basic	2018-06-22	19:12	57° 46,560'	86° 01,576'	Optics Lisst ↑	127,12	268	11	1	-1,539	1012,59	89	8
1	BS# 36	Basic	2018-06-22	19:15	57° 46,566'	86° 01,577'	Optics IOP ↓	127,26	267	9,9	1,1	-1,561	1012,67	89	8
1	BS# 36	Basic	2018-06-22	19:31	57° 46,566'	86° 01,605'	Helicopter ↑	127,05	264	10,3	1,3	-1,54	1012,57	89	8
1	BS# 36	Basic	2018-06-22	19:54	57° 46,562'	86° 01,632'	Optics IOP ↑	126,73	272	10,5	1	-1,554	1012,81	90	8
1	BS# 36	Basic	2018-06-22	19:56	57° 46,570'	86° 01,637'	Box core ↓	126,44	265	10,9	0,9	-1,562	1012,82	89	8
1	BS# 36	Basic	2018-06-22	19:59	57° 46,573'	86° 01,648'	Box core (bottom)	126,37	266	12,8	1	-1,554	1012,54	90	8
1	BS# 36	Basic	2018-06-22	20:04	57° 46,558'	86° 01,658'	Box core ↑	126,72	258	13,7	1,1	-1,529	1012,73	89	8
1	BS# 36	Basic	2018-06-22	20:13	57° 46,552'	86° 01,671'	Box core ↓	126,96	260	9,9	1,1	-1,499	1012,83	89	8
1	BS# 36	Basic	2018-06-22	20:16	57° 46,548'	86° 01,675'	Box core (bottom)	127,07	255	11	1,1	-1,51	1012,76	89	8
1	BS# 36	Basic	2018-06-22	20:21	57° 46,542'	86° 01,681'	Box core ↑	127,3	261	13,5	1,1	-1,511	1012,59	87	8
1	BS# 37	Nutrient	2018-06-23	2:49	58° 28,084'	86° 13,549'	Water Sampling ↓	166	297	8,2	0,6	8,2	1012,91	94	9
1	BS# 37	Nutrient	2018-06-23	3:07	58° 28,135'	86° 13,531'	CTD Rosette ↓	169,68	253	6,9	0	6,9	1013,02	93	9
1	BS# 37	Nutrient	2018-06-23	3:23	58° 28,182'	86° 13,503'	Water Sampling ↑	169,17	333	7	-0,6	7	1013	93	9
1	BS# 37	Nutrient	2018-06-23	3:51	58° 28,272'	86° 13,453'	CTD Rosette ↑	168	236	4,2	-0,3	-1,451	1013,14	94	9
1	BS# 38	Basic	2018-06-23	12:39	58° 47,536'	86° 12,809'	Helicopter ↓	183,16	292	6,9	0,3	6,9	1015,46	91	9
1	BS# 38	Basic	2018-06-23	14:27	58° 42,954'	86° 18,735'	Skippy boat ↓	182,45	258	9,5	0,3	9,5	1015,88	92	9
1	BS# 38	Basic	2018-06-23	14:33	58° 42,967'	86° 18,732'	Helicopter ↑	182,46	266	10,7	0,4	10,7	1015,86	92	9
1	BS# 38	Basic	2018-06-23	14:54	58° 43,011'	86° 18,788'	Ice Cage ↓	181,72	259	7	0,8	-1,572	1016	91	9
1	BS# 38	Basic	2018-06-23	15:16	58° 43,131'	86° 18,640'	PNF ↓	181,59	298	8,8	0,5	-1,41	1016,17	92	9
1	BS# 38	Basic	2018-06-23	15:21	58° 43,144'	86° 18,641'	PNF ↑	181,56	264	4,4	1,2	-1,537	1016,18	92	9
1	BS# 38	Basic	2018-06-23	16:02	58° 43,343'	86° 18,302'	CTD Rosette ↓	181,31	269	6,5	2,3	-1,5	1016,42	85	9
1	BS# 38	Basic	2018-06-23	16:33	58° 43,405'	86° 18,099'	CTD Rosette ↑	180,99	276	9,7	1,4	-1,492	1016,52	90	9
1	BS# 38	Basic	2018-06-23	17:06	58° 43,516'	86° 18,358'	Helicopter ↓	180,74	283	8,4	0,8	-1,5	1016,55	93	9
1	BS# 38	Basic	2018-06-23	17:25	58° 43,559'	86° 18,487'	Ice Cage ↓	181,05	263	7	1,3	-1,547	1016,82	91	9
1	BS# 38	Basic	2018-06-23	17:30	58° 43,573'	86° 18,481'	Ice cage ↑	180,62	262	7,6	1,2	-1,525	1016,85	91	9
1	BS# 38	Basic	2018-06-23	17:46	58° 43,592'	86° 18,288'	Tucker net ↓	180,03	272	6,9	0,8	-1,338	1016,82	92	9
1	BS# 38	Basic	2018-06-23	17:56	58° 43,824'	86° 18,186'	Tucker net ↑	179,83	283	8,8	1,3	-1,374	1016,84	91	9
1	BS# 38	Basic	2018-06-23	18:20	58° 43,740'	86° 18,370'	Ice cage ↓	180,15	273	7,4	1,2	-1,352	1016,98	91	9
1	BS# 38	Basic	2018-06-23	18:27	58° 43,762'	86° 18,343'	Ice cage ↑	180,25	278	6,9	1,4	-1,478	1017,02	91	9
1	BS# 38	Basic	2018-06-23	18:38	58° 43,783'	86° 18,291'	Skippy boat ↑	180,07	277	6,9	1,1	-1,48	1017,02	92	9
1	BS# 38	Basic	2018-06-23	18:55	58° 43,853'	86° 18,147'	Helicopter ↑	181,07	292	7,8	1,2	-1,466	1016,98	92	9
1	BS# 38	Basic	2018-06-23	19:17	58° 43,825'	86° 18,117'	CTD Rosette ↓	180,99	311	2,5	2	-1,334	1017,12	90	9
1	BS# 38	Basic	2018-06-23	19:56	58° 43,872'	86° 17,961'	CTD Rosette ↑	180,64	278	1,1	3,7	-1,467	1017,43	81	9
1	BS# 38	Basic	2018-06-23	20:03	58° 43,891'	86° 17,998'	Optics IOP ↓		270	6,5	2	-1,509	1017,5	89	9
1	BS# 38	Basic	2018-06-23	20:37	58° 43,870'	86° 17,852'	Optics IOP ↑	180,67	253	8	1,1	-1,487	1017,43	92	9
1	BS# 38	Basic	2018-06-23	20:40	58° 43,868'	86° 17,846'	Optics Lisst ↓	180,63	260	7,2	1,1	-1,53	1017,49	92	9
1	BS# 38	Basic	2018-06-23	20:55	58° 43,862'	86° 17,788'	Optics Lisst ↑	180,57	258	6,9	1	-1,376	1017,48	92	9
1	BS# 38	Basic	2018-06-23	21:01	58° 43,892'	86° 17,982'	Optics IOP ↓	179,51	278	8	1,2	-1,178	1017,43	92	9
1	BS# 38	Basic	2018-06-23	21:45	58° 43,816'	86° 17,642'	Optics IOP ↑	179,84	270	9,1	1,4	-1,467	1017,56	91	9
1	BS# 38	Basic	2018-06-23	21:52	58° 43,790'	86° 17,727'	Monster net ↓	180,68	260	6,9	1,4	-1,451	1017,59	92	9
1	BS# 38	Basic	2018-06-23	22:03	58° 43,803'	86° 17,715'	Monster net ↑	180,48	267	7,8	1,6	-1,435	1017,63	91	9
1	BS# 38	Basic	2018-06-23	22:20	58° 43,803'	86° 17,715'	Agassis trawl ↓	180,48	267	7,8	1,6	-1,435	1017,63	91	9
1	BS# 38	Basic	2018-06-23	22:40	58° 43,666'	86° 17,861'	Agassis trawl ↑	180,35	32	0,6	1,5	-1,133	1017,66	92	9
1	BS# 38	Basic	2018-06-23	22:55	58° 43,490'	86° 17,881'	Box core ↓	179,82	255	7,2	1,4	-1,532	1017,59	91	9
1	BS# 38	Basic	2018-06-23	23:00	58° 43,465'	86° 17,860'	Box core (bottom)	180,07	262	8	1,2	-1,431	1017,6	92	9
1	BS# 38	Basic	2018-06-23	23:03	58° 43,452'	86° 17,838'	Box core ↑	179,86	256	7,4	1,2	-1,381	1017,66	92	9
1	BS# 38	Basic	2018-06-23	23:17	58° 43,411'	86° 17,754'	Box core ↓	179,83	272	5	1,3	-1,47	1017,5	92	9

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1	BS# 38	Basic	2018-06-23	23:21	58° 43,405'	86° 17,740'	Box core (bottom)	179,9	285	5,7	1,6	-1,485	1017,57	90	9
1	BS# 38	Basic	2018-06-23	23:25	58° 43,387'	86° 17,733'	Box core ↑	179,66	259	6,3	1,8	-1,462	1017,58	90	9
1	BS# 39	Nutrient	2018-06-24	6:19	58° 28,485'	87° 26,310'	CTD Rosette ↓	182,66	231	9,1	2,1	9,1	1018,27	77	9
1	BS# 39	Nutrient	2018-06-24	6:36	58° 28,609'	87° 26,349'	Water Sampling ↓	183,76	234	8,9	2,7	8,9	1018,23	74	9
1	BS# 39	Nutrient	2018-06-24	6:59	58° 28,751'	87° 26,408'	Water Sampling ↑	183,95	223	8,8	1,4	8,8	1018,29	79	9
1	BS# 39	Nutrient	2018-06-24	7:03	58° 28,785'	87° 26,404'	CTD Rosette ↑	184,74	240	8,2	1,6	-1,47	1018,33	80	9
1	BS# 40	Basic	2018-06-24	13:19	58° 14,602'	88° 35,339'	Skippy boat ↓	91,55	67	6,3	0,4	-1,485	1018,68	93	9
1	BS# 40	Basic	2018-06-24	14:51	58° 14,113'	88° 34,358'	Ice Team via Helico ↓	88,52	62	5,1	1	-1,517	1018,74	92	9
1	BS# 40	Basic	2018-06-24	15:14	58° 14,050'	88° 34,097'	PNF ↓	90,44	22	3,2	1,2	-1,524	1018,95	91	9
1	BS# 40	Basic	2018-06-24	15:18	58° 14,038'	88° 34,076'	PNF ↑	89,65	6	3	1,1	-1,46	1018,98	92	9
1	BS# 40	Basic	2018-06-24	16:16	58° 13,957'	88° 33,808'	CTD Rosette ↓	90,62	62	4,2	1	-1,504	1019,05	92	9
1	BS# 40	Basic	2018-06-24	16:43	58° 13,978'	88° 33,807'	CTD Rosette ↑	93,58	22	1,5	1,5	-1,502	1019,35	91	9
1	BS# 40	Basic	2018-06-24	16:57	58° 13,995'	88° 33,838'	Ice Team via Helico ↑	86,05	20	2,3	1,7	-1,483	1019,41	90	9
1	BS# 40	Basic	2018-06-24	17:16	58° 14,037'	88° 33,907'	Helicopter ↑	87,47	54	6,3	1,1	-1,49	1019,45	92	9
1	BS# 40	Basic	2018-06-24	17:44	58° 14,183'	88° 34,231'	Skippy boat ↑	86,85	41	3,4	2	-1,511	1019,53	88	9
1	BS# 40	Basic	2018-06-24	17:56	58° 14,233'	88° 34,312'	Monster net ↓	87,02	44	2,5	2,3	-1,475	1019,59	85	9
1	BS# 40	Basic	2018-06-24	18:02	58° 14,259'	88° 34,350'	Monster net ↑	87,12				-1,503			9
1	BS# 40	Basic	2018-06-24	18:47	58° 14,387'	88° 34,895'	CTD Rosette ↓	87,07	65	3,4	2,2	-1,47	1019,34	87	9
1	BS# 40	Basic	2018-06-24	19:18	58° 14,572'	88° 35,326'	CTD Rosette ↑	87,97	73	6,1	1,3	-1,471	1019,07	91	9
1	BS# 40	Basic	2018-06-24	19:30	58° 14,653'	88° 35,408'	Box core ↓	89,1	129	3,8	2,9	-1,499	1019,07	85	9
1	BS# 40	Basic	2018-06-24	19:32	58° 14,660'	88° 35,435'	Box core (bottom)	89,43	84	1,5	3	-1,501	1019,02	84	9
1	BS# 40	Basic	2018-06-24	19:37	58° 14,675'	88° 35,502'	Box core ↑	89,77	182	0,8	3,1	-1,504	1019,04	81	9
1	BS# 40	Basic	2018-06-24	19:49	58° 14,853'	88° 35,751'	Box core ↓	88,93	109	5,1	3,9	-1,481	1019	81	9
1	BS# 40	Basic	2018-06-24	19:52	58° 14,865'	88° 35,791'	Box core (bottom)	90,08	129	3,8	3,8	-1,508	1018,99	81	9
1	BS# 40	Basic	2018-06-24	19:55	58° 14,875'	88° 35,838'	Box core ↑	92,5	123	0,2	3,7	-1,504	1018,99	83	9
1	BS# 41	Nutrient	2018-06-25	4:17	58° 01,129'	89° 46,846'	Water Sampling ↓	71	166	17,5	3,8	-0,68	1013,41	73	3
1	BS# 41	Nutrient	2018-06-25	4:18	58° 01,132'	89° 46,842'	CTD Rosette ↓	71,08	158	17,1	4,4	-0,572	1013,46	73	3
1	BS# 41	Nutrient	2018-06-25	4:39	58° 01,357'	89° 46,844'	CTD Rosette ↑	72,68	214	0,8	4,2	-0,573	1013,27	78	3
1	BS# 41	Nutrient	2018-06-25	4:40	58° 01,363'	89° 46,840'	Water Sampling ↑	73,04	77	2,1	3,9	-0,559	1013,22	78	3
1	NE03	Mooring	2018-06-25	13:16	57° 49,670'	90° 52,552'	Mooring ↑	53,82	220	21,1	9,2	0,313	1005,64	74	
1	NE03	Mooring	2018-06-25	17:43	57° 29,956'	91° 48,115'	ADCP ↓	44	216	26,8	14,2	1,257	1004,82	84	
1	NE03	Mooring	2018-06-25	17:59	57° 30,265'	91° 47,865'	Wave buoy ↓		209	24,8	14,1	1,069	1004,84	85	
1	CM 03	Basic	2018-06-27	12:27	63° 11,499'	81° 58,005'	CTD Rosette ↓	192,62	304	23,2	1,6	0,141	1005,73	87	1
1	CM 03	Basic	2018-06-27	13:04	63° 11,491'	81° 57,188'	CTD Rosette ↑	191,5	300	18,1	1,9	0,179	1005,77	84	1
1	CM 03	Basic	2018-06-27	13:32	63° 11,456'	81° 56,353'	Monster Net ↓	190,49	295	20,2	2,2	0,206	1005,39	85	1
1	CM 03	Basic	2018-06-27	13:33	63° 11,460'	81° 56,343'	Water Sampling ↓	190,39	296	18,7	2,2	0,244	1005,5	85	1
1	CM 03	Basic	2018-06-27	13:44	63° 11,511'	81° 56,267'	Monster Net ↑	189,54	304	17,1	2,9	0,21	1005,18	84	1
1	CM 03	Basic	2018-06-27	13:54	63° 11,497'	81° 55,883'	Water Sampling ↑		22	0,8	2,5	0,177	1005,22	83	1
1	CM 03	Basic	2018-06-27	14:07	63° 11,296'	81° 57,618'	Tucker Net ↓	192,04	301	21,9	1,7	0,231	1005,05	87	1
1	CM 03	Basic	2018-06-27	14:18	63° 11,450'	81° 56,911'	Tucker Net ↑	191,26	287	17,5	1,6	0,218	1004,71	86	1
1	CM 03	Basic	2018-06-27	14:37	63° 11,323'	81° 56,188'	Beam Trawl ↓	192,66	308	12,6	5,4	0,262	1004,9	70	1
1	CM 03	Basic	2018-06-27	15:07	63° 11,384'	81° 53,786'	Beam Trawl ↑	189,12	313	14,9	1,5	-0,22	1004,96	86	1
1	CMO01	Basic	2018-06-28	15:05	59° 58,610'	91° 56,422'	Mooring ↓	105,22	108	4,6	1,8	1,714	1008,15	84	0
1	BS# 44	Basic	2018-06-28	15:29	59° 58,431'	91° 57,156'	Mooring ↑	106,1	93	2,1	2	1,979	1008,23	81	0
1	BS# 44	Basic	2018-06-28	15:59	59° 58,441'	91° 57,103'	AOP ↓	106,77	62	2,9	1,8	1,956	1008,36	81	0
1	BS# 44	Basic	2018-06-28	16:41	59° 58,724'	91° 57,031'	AOP ↑	101,07	63	2,7	2,1	2,144	1008,56	81	0
1	BS# 44	Basic	2018-06-28	16:44	59° 58,737'	91° 57,001'	PNF ↓	101,05	61	3	2,1	2,115	1008,59	81	0
1	BS# 44	Basic	2018-06-28	16:49	59° 58,761'	91° 56,989'	PNF ↑	102,31	50	3,4	2	2,007	1008,71	81	0
1	BS# 44	Basic	2018-06-28	17:00	59° 58,850'	91° 56,937'	Helicopter ↓	104,36	68	3	2,4	2,055	1008,69	81	0
1	BS# 44	Basic	2018-06-28	17:11	59° 58,483'	91° 57,036'	CTD Rosette ↓	106,59	44	3,2	2,4	2,128	1008,7	81	0
1	BS# 44	Basic	2018-06-28	17:35	59° 58,665'	91° 56,868'	Water Sampling ↓	101,09	71	2,3	2,4	1,926	1008,64	81	0
1	BS# 44	Basic	2018-06-28	17:39	59° 58,708'	91° 56,813'	CTD Rosette ↑	101,79	65	3	2,3	1,865	1008,63	82	0

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1	BS# 44	Basic	2018-06-28	17:47	59° 58,771'	91° 56,702'	Water Sampling ↑	100,35	79	1,9	2,4	1,848	1008,72	81	0
1	BS# 44	Basic	2018-06-28	18:03	59° 58,366'	91° 57,645'	Hydrobios ↓	105,46	208	0,4	3,3	1,495	1008,88	79	0
1	BS# 44	Basic	2018-06-28	18:10	59° 58,417'	91° 57,645'	Hydrobios ↑	104,35	111	1,9	3	1,738	1008,96	81	0
1	BS# 44	Basic	2018-06-28	18:29	59° 58,447'	91° 57,580'	Tucker net ↓	105,98	24	2,1	3,9	1,631	1008,99	75	0
1	BS# 44	Basic	2018-06-28	18:47	59° 59,074'	91° 57,664'	Tucker net ↑	105,79	201	2,7	3	1,562	1009,04	77	0
1	BS# 44	Basic	2018-06-28	18:59	59° 58,455'	91° 57,079'	CTD Rosette ↓	105,01	210	2,9	2,6	1,65	1009,03	82	0
1	BS# 44	Basic	2018-06-28	19:28	59° 58,832'	91° 56,671'	CTD Rosette ↑	102,1	280	3,4	3,4	1,543	1009,07	78	
1	BS# 44	Basic	2018-06-28	19:38	59° 58,226'	91° 57,229'	Agassis trawl ↓	103,79	279	1,9	2,5	2,305	1009,15	81	0
1	BS# 44	Basic	2018-06-28	19:48	59° 58,520'	91° 57,315'	Agassis trawl ↑	104,68	264	2,3	2,6	1,815	1009,17	80	0
1	BS# 44	Basic	2018-06-28	20:22	59° 58,453'	91° 57,441'	Beam Trawl ↓	104,26	257	2,1	2,6	1,746	1009,2	78	0
1	BS# 44	Basic	2018-06-28	20:45	59° 59,312'	91° 57,331'	Beam Trawl ↑	105,21	248	2,5	2,6	1,757	1009,14	81	0
1	Nelson River	River	2018-06-29	10:54	57° 15,074'	91° 57,771'	Barge ↓	16,69	135	2,9	4,6	5,979	1009,95	87	0
1	Nelson River	River	2018-06-29	12:40	00° 00,000'	00° 00,000'	Zodiac ↓	17	70	17	3,6	6,24	1013,14	90	0
1	Nelson River	River	2018-06-29	16:17	57° 13,531'	92° 01,169'	Zodiac ↑	17,94	50	12,4	4,8	1,541	1012,11	90	0
1	Nelson River	River	2018-06-29	16:52	57° 15,700'	92° 02,021'	Zodiac ↓	19	52	12,9	4,3	5,467	1012,18	89	0
1	Nelson River	River	2018-06-29	19:17	57° 16,236'	92° 02,796'	Helicopter ↓	16,34	50	16,9	4,4	6,142	1013,21	80	0
1	Nelson River	River	2018-06-29	19:46	57° 16,403'	92° 02,644'	Zodiac ↑	16,89	38	18,3	4,4	5,279	1013,16	78	0
1	Nelson River	River	2018-06-29	20:47	57° 17,701'	92° 02,311'	Zodiac ↓	17,96	45	17,9	4,2	5,738	1013,99	76	0
1	Nelson River	River	2018-06-29	21:52	57° 15,828'	92° 03,993'	Barge ↑	13	61	3,8	5,5	6,819	1014,37	76	0
1	Nelson River	River	2018-06-29	22:24	57° 16,765'	92° 01,676'	Helicopter ↑	16,7	67	23,4	4,4	6,96	1014,44	78	0
1	Nelson River	River	2018-06-29	23:35	57° 14,509'	91° 57,502'	Zodiac ↑	16,73	45	16	4,3	2,954	1014,54	80	0
1	Nelson River	River	2018-06-30	11:08	57° 14,811'	91° 56,509'	Barge ↓	17,66	79	9,7	3,6	3,574	1017,17	95	0
1	Nelson River	River	2018-06-30	11:42	57° 14,686'	91° 57,286'	Zodiac ↓	17,09	71	10,7	2,5	2,933	1016,86	99	0
1	Nelson River	River	2018-06-30	12:54	57° 15,673'	91° 57,469'	Agassis trawl ↓	18,47	71	14,7	1,8	4,394	1016,1	99	0
1	Nelson River	River	2018-06-30	13:08	57° 15,048'	91° 57,442'	Agassis trawl ↑	18,4	72	12,9	1,9	4,171	1016,32	99	0
1	Nelson River	River	2018-06-30	13:22	57° 14,563'	91° 57,411'	Beam Trawl ↓	18,03	68	10,7	1,9	3,914	1016,14	99	0
1	Nelson River	River	2018-06-30	13:37	57° 13,873'	91° 57,213'	Beam Trawl ↑	17,34	60	15,4	2	6,625	1015,87	99	0
1	Nelson River	River	2018-06-30	13:39	57° 13,799'	91° 57,217'	Water Sampling ↓	17,27	66	14,3	1,9	6,345	1015,98	99	0
1	Nelson River	River	2018-06-30	13:51	57° 13,378'	91° 57,321'	CTD Rosette ↓	16,66	67	10,3	2,2	5,271	1016,28	99	0
1	Nelson River	River	2018-06-30	13:55	57° 13,230'	91° 57,381'	Water Sampling ↑	16,48	55	13,3	2,1	5,087	1016,4	99	0
1	Nelson River	River	2018-06-30	14:01	57° 13,055'	91° 57,511'	CTD Rosette ↑	16,3	40	16	2,2	5,011	1018,3	99	0
1	Nelson River	River	2018-06-30	14:30	57° 15,157'	91° 57,765'	Box core ↓	20	75	14,5	2,2	6,566	1016,93	99	0
1	Nelson River	River	2018-06-30	14:31	57° 15,156'	91° 57,779'	Box core (bottom)	19,06	82	16,4	2	6,595	1016,86	99	0
1	Nelson River	River	2018-06-30	14:31	57° 15,156'	91° 57,779'	Box core ↑	19,06	82	16,4	2	6,595	1016,86	99	0
1	Nelson River	River	2018-06-30	14:49	57° 14,867'	91° 58,420'	Box core ↑	18	174	0,6	2,5	2,516	1017,05	99	0
1	Nelson River	River	2018-06-30	16:45	57° 15,156'	91° 57,779'	Zodiac ↑	19,06	82	16,4	2	6,595	1016,86	99	0
1	Nelson River	River	2018-06-30	18:16	57° 14,608'	92° 01,555'	Zodiac ↓	18	84	16,2	2,3	4,846	1014,97	94	0
1	Nelson River	River	2018-06-30	18:28	57° 15,009'	92° 00,414'	Agassis trawl ↓	16,89	57	19	2,9	4,984	1015,25	92	0
1	Nelson River	River	2018-06-30	18:33	57° 15,029'	92° 00,677'	Agassis trawl ↑	17,68	60	17,9	2,5	4,427	1015,14	91	0
1	Nelson River	River	2018-06-30	18:36	57° 15,040'	92° 00,822'	Agassis trawl ↓	16,54	59	20	2,4	4,383	1015,17	92	0
1	Nelson River	River	2018-06-30	18:45	57° 15,056'	92° 01,239'	Agassis trawl ↑	17	60	19	2,6	4,98	1014,94	91	0
1	Nelson River	River	2018-06-30	18:55	57° 15,078'	92° 01,755'	Beam trawl ↓	16,42	64	17,3	2,7	5,459	1015,2	92	0
1	Nelson River	River	2018-06-30	19:12	57° 14,932'	92° 02,959'	Beam trawl ↑	12,77	49	21,5	2,8	6,306	1014,71	91	0
1	Nelson River	River	2018-06-30	19:29	57° 15,524'	92° 03,380'	Barge ↑	15	53	24,4	3,1	4,282	1014,26	91	0
1	Nelson River	River	2018-06-30	20:11	57° 16,946'	92° 02,392'	Helicopter ↓	16,82	71	21,7	3,1	4,824	1014,24	90	0
1	Nelson River	River	2018-06-30	20:40	57° 17,079'	92° 04,337'	Zodiac ↑	15,58	48	21,1	2,9	6,339	1013,33	92	0
1	Nelson River	River	2018-06-30	20:55	57° 17,728'	92° 03,812'	CTD Rosette ↓	19,2	74	26,8	3	2,947	1013,64	92	0
1	Nelson River	River	2018-06-30	21:06	57° 17,993'	92° 03,763'	CTD Rosette ↑	17,78	77	25,7	2,8	3,875	1013,24	92	0
1	Nelson River	River	2018-06-30	21:17	57° 18,242'	92° 03,653'	Water Sampling ↓	16,2	73	26,7	3,1	4,553	1013,12	92	0
1	Nelson River	River	2018-06-30	21:37	57° 18,685'	92° 03,611'	Water Sampling ↑	16,53	72	24,9	3	3,498	1012,96	91	0
1	Nelson River	River	2018-06-30	21:50	57° 18,198'	92° 01,717'	Helicopter ↑	20,69	85	24,6	3,1	5,959	1012,62	91	0
1	BS# 46	Full	2018-07-01	11:26	57° 23,897'	92° 04,362'	CTD Rosette ↓	15,7	94	23,8	2,6	4,595	1005,93	97	0

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1	BS# 46	Full	2018-07-01	11:37	57° 23,963'	92° 04,471'	CTD Rosette ↑	14,67	81	22,5	2,3	4,337	1006,18	97	0
1	BS# 46	Full	2018-07-01	12:27	57° 23,770'	91° 58,559'	CTD Rosette ↓	27,23	81	20,6	2,2	3,111	1006,42	97	0
1	BS# 46	Full	2018-07-01	12:41	57° 23,704'	91° 58,695'	CTD Rosette ↑	27,76	92	22,5	2,2	1,825	1007,18	97	0
1	BS# 46	Full	2018-07-01	13:15	57° 23,658'	91° 51,977'	CTD Rosette ↓	31,56	86	19,4	1,8	2,096	1007,38	96	0
1	BS# 46	Full	2018-07-01	13:29	57° 23,534'	91° 52,193'	CTD Rosette ↑	33	80	23	1,9	2,01	1007,12	95	0
1	BS# 46	Full	2018-07-01	14:12	57° 30,521'	91° 48,162'	PNF ↓	40,16	131	9,5	2,7	2,444	1005,2	89	0
1	BS# 46	Full	2018-07-01	14:18	57° 30,405'	91° 48,348'	PNF ↑	39,53	149	8,4	4,3	2,487	1005,13	83	0
1	BS# 46	Full	2018-07-01	14:32	57° 30,193'	91° 48,770'	CTD Rosette ↓	41,2	80	21,9	1,8	2,378	1004,8	91	0
1	BS# 46	Full	2018-07-01	14:54	57° 29,811'	91° 49,441'	CTD Rosette ↑	43	80	20	3,6	1,305	1004,82	87	0
1	BS# 46	Full	2018-07-01	15:02	57° 29,386'	91° 49,253'	Helicopter ↓	45	82	23	2	2,41	1004,51	91	0
1	BS# 46	Full	2018-07-01	15:31	57° 30,315'	91° 47,742'	Helicopter ↑	46	77	30,1	1,8	2,512	1004,33	94	0
1	BS# 46	Full	2018-07-01	15:38	57° 30,459'	91° 47,893'	Tucker Net ↓	42,57	72	19,2	2,3	2,507	1004,67	94	0
1	BS# 46	Full	2018-07-01	15:51	57° 30,148'	91° 48,807'	Tucker Net ↑	42,71	72	18,8	1,3	2,524	1004,17	96	0
1	BS# 46	Full	2018-07-01	16:08	57° 29,809'	91° 49,180'	Monster net ↓	44,32	83	12	6,9	2,054	1005,62	82	0
1	BS# 46	Full	2018-07-01	16:12	57° 29,755'	91° 49,255'	Monster net ↑	44,5	74	21,1	2,9	1,36	1005,49	93	0
1	BS# 46	Full	2018-07-01	16:40	57° 30,205'	91° 48,532'	Optics IOP ↓	43,23	68	19,4	2,4	1,084	1005,12	96	0
1	BS# 46	Full	2018-07-01	16:54	57° 30,049'	91° 48,813'	Optics IOP ↑	43,93	84	22,7	1,5	1,304	1005,24	96	0
1	BS# 46	Full	2018-07-01	16:56	57° 30,024'	91° 48,828'	Optics Lisst ↓	44,02	76	23,4	1,9	1,796	1005,26	96	0
1	BS# 46	Full	2018-07-01	17:00	57° 29,979'	91° 48,904'	Optics Lisst ↑	44,17	80	18,7	2	2,422	1005,35	96	0
1	BS# 46	Full	2018-07-01	17:10	57° 29,862'	91° 48,979'	AOP ↓	44,67	82	21,5	4,6	2,203	1005,44	87	0
1	BS# 46	Full	2018-07-01	17:32	57° 29,691'	91° 48,759'	AOP ↑	46,26	84	18,7	3,9	1,695	1005,34	89	0
1	BS# 46	Full	2018-07-01	17:39	57° 29,646'	91° 48,886'	CTD Rosette ↓	46,23	76	20,9	1,9	1,77	1005,17	94	0
1	BS# 46	Full	2018-07-01	17:57	57° 29,586'	91° 49,202'	CTD Rosette ↑	45,31	73	19,8	2,5	2,238	1005,15	92	0
1	BS# 46	Full	2018-07-01	18:13	57° 30,191'	91° 48,334'	Agassis trawl ↓	44,06	75	22,5	1,4	1,868	1005,14	96	0
1	BS# 46	Full	2018-07-01	18:23	57° 30,063'	91° 48,907'	Agassis trawl ↑	43,51	61	18,8	1,1	2,034	1004,83	97	0
1	BS# 46	Full	2018-07-01	18:42	57° 30,148'	91° 48,521'	Beam trawl ↓	43,35	70	19	3,3	1,803	1005,1	92	0
1	BS# 46	Full	2018-07-01	19:00	57° 29,890'	91° 49,904'	Beam trawl ↑	43,41	71	16,6	1,1	2,362	1005,09	97	0
1	BS# 46	Full	2018-07-01	19:25	57° 30,202'	91° 48,205'	Box core ↓	43	69	21,1	3,6	1,278	1005,19	84	0
1	BS# 46	Full	2018-07-01	19:32	57° 30,210'	91° 48,336'	Box core ↑	43,5	53	17,9	1,4	1,363	1004,84	96	0
1	BS# 46	Full	2018-07-01	20:15	57° 30,326'	91° 48,107'	Zodiac ↓	43,06	44	22,1	1,1	1,391	1004,5	98	0
1	BS# 46	Full	2018-07-01	21:05	57° 30,326'	91° 48,107'	Wave buoy ↑	43,06	44	22,1	1,1	1,391	1004,5	98	0
1	BS# 46	Full	2018-07-01	21:54	57° 30,252'	91° 48,060'	Mooring and Zodiac ↑	42,33	61	21,1	1	1,858	1004,82	97	0
Leg 2a															
2a	731	Nutrient	2018-07-08	12:55	55° 24,500'	77° 56,004'	Secchi Disk ↓	138.3	241	24.6	8.3	3.389	993.38	99	
2a	731	Nutrient	2018-07-08	13:05	55° 24,446'	77° 55,855'	CTD Rosette ↓	136	240	23	8.3	4.05	996.01	99	0
2a	731	Nutrient	2018-07-08	13:40	55° 24,523'	77° 55,002'	CTD Rosette ↑	114.86	231	19.6	7.8	3.538	993.91	99	0
2a	730	Nutrient	2018-07-08	18:40	56° 10,537'	76° 41,734'	Water Sampling	141.53	239	25.7	6.7	4.154	994.20	99	0
2a	730	Nutrient	2018-07-08	18:50	56° 11,074'	76° 43,419'	CTD Rosette ↓	141.47	219	30.3	6.2	3.955	992.95	99	0
2a	730	Nutrient	2018-07-08	19:45	56° 11,231'	76° 43,125'	CTD Rosette ↑	143.18	223	21.3	9.6	3.941	993.98	94	0
2a	736	Basic	2018-07-09	8:40	58° 25,447'	78° 18,139'	Tucker Net ↓	89.06	280	3.2	1.7	2.265	998.48	99	0
2a	736	Basic	2018-07-09	8:50	58° 25,331'	78° 17,644'	Tucker Net ↑ ↓	87.32	298	3.6	1.2	2.317	998.37	99	0
2a	736	Basic	2018-07-09	8:57	58° 25,355'	78° 17,209'	Tucker Net ↑	81.43	292	3.4	0.9	2.004	998.43	99	0
2a	736	Basic	2018-07-09	9:17	58° 25,625'	78° 18,591'	Tucker Net ↓	89.32	241	1.1	1.4	2.644	998.48	99	0
2a	736	Basic	2018-07-09	9:28	58° 25,352'	78° 18,078'	Tucker Net ↑	90.95	271	2.1	1.5	2.150	998.49	99	0
2a	736	Basic	2018-07-09	9:52	58° 25,442'	78° 18,308'	Zodiac ↓	91.73	265	8.6	1.1	3.296	998.51	99	0
2a	736	Basic	2018-07-09	10:03	58° 25,473'	78° 18,336'	Monster Net ↓	91.25	262	7.6	1.2	3.070	998.49	99	0
2a	736	Basic	2018-07-09	10:11	58° 25,474'	78° 18,414'	Monster Net ↑	91	305	6.3	1.4	3.252	998.58	99	0
2a	736	Basic	2018-07-09	10:42	58° 25,497'	78° 18,729'	PNF ↓	95.28	298	7.2	1.1	3.378	998.44	98	0
2a	736	Basic	2018-07-09	11:03	58° 25,431'	78° 18,652'	CTD Rosette ↓	95.64	295	8.8	1.4	3.143	998.62	98	0
2a	736	Basic	2018-07-09	11:44	58° 25,418'	78° 19,436'	CTD Rosette ↑	112.14	106	3.6	1.6	3.159	998.57	97	0
2a	736	Basic	2018-07-09	12:23	58° 25,599'	78° 18,373'	Zodiac ↑	88.58	160	3.0	1.8	3.198	998.57	96	0
2a	736	Basic	2018-07-09	12:42	58° 25,771'	78° 18,844'	Agassiz Trawl ↓	88	202	5.9	1.8	3.252	998.84	97	0

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2a	736	Basic	2018-07-09	12:51	58° 25,947'	78° 19,222'	Agassiz Trawl ↑	88.89	204	5.7	1.6	2.982	998.80	97	0
2a	689	Basic	2018-07-11	22:16	62° 16,127'	75° 32,010'	Zodiac ↓	94	93	6.5	4.9	1.11	1013.26	90	3
2a	689	Basic	2018-07-11	22:33	62° 20,429'	75° 32,145'	PNF ↓	118	60	5.3	5.8	0.84	1013.12	87	3
2a	689	Basic	2018-07-11	22:55	62° 20,539'	75° 32,078'	CTD Rosette ↓	118	53	5.5	6.2	1.16	1013.19	85	1
2a	689	Basic	2018-07-11	23:30	62° 20,578'	75° 32,065'	CTD Rosette ↑	119	22	3.0	6.0	0.61	1013.08	85	1
2a	689	Basic	2018-07-11	23:43	62° 20,733'	75° 31,873'	Tucker Net ↓	127	57	5.9	4.9	0.87	1013.03	90	1
2a	689	Basic	2018-07-12	0:11	61° 21,310'	75° 32,848'	Tucker Net ↑	140	57	5.9	4.9	0.87	1013.03	90	1
2a	689	Basic	2018-07-12	0:43	62° 18,331'	75° 30,321'	Zodiac ↑	75	57	5	4.2	1.96	1012.88	92	1
2a	689	Basic	2018-07-12	1:04	62° 20,333'	75° 31,473'	Tucker Net ↓	119.91	305	5.9	3.7	0.455	1010.72	93	1
2a	689	Basic	2018-07-12	1:19	62° 20,813'	75° 31,626'	Tucker Net ↑	129.12	315	6.9	3.3	1.593	1010.70	94	1
2a	689	Basic	2018-07-12	1:44	62° 20,743'	75° 32,030'	Monster Net ↓	126.47	142	0.0	3.8	-0.380	1010.90	90	1
2a	689	Basic	2018-07-12	1:52	62° 20,746'	75° 32,072'	Monster Net ↑	127.11	344	0.0	3.8	-0.609	1010.82	90	1
2a	689	Basic	2018-07-12	2:13	62° 20,620'	75° 31,938'	Agassiz Trawl ↓	122.68	329	1.7	3.6	0.275	1010.85	92	1
2a	689	Basic	2018-07-12	2:24	62° 20,905'	75° 32,221'	Agassiz Trawl ↑	131.13	286	3.6	2.9	2.448	1010.95	94	1
2a	341	Basic	2018-07-12	14:27	61° 57,900'	70° 45,900'	CTD Rosette ↓	314	147	8.6	5.1	2.942	1012.96	85	0
2a	341	Basic	2018-07-12	15:00	61° 57,890'	70° 46,070'	CTD Rosette ↑	312	142	8.0	7.9	2.263	1012.80	81	0
2a	341	Basic	2018-07-12	15:16	61° 57,850'	70° 45,963'	Tucker Net ↓	312	156	10.7	7.4	3.229	1012.74	82	0
2a	341	Basic	2018-07-12	15:30	61° 57,025'	70° 45,514'	Tucker Net ↑	312	152	12.0	6.0	2.535	1013.11	85	0
2a	341	Basic	2018-07-12	15:46	61° 57,048'	70° 45,499'	Tucker Net ↓	309	153	11.8	5.9	2.670	1013.10	85	0
2a	341	Basic	2018-07-12	16:01	61° 56,554'	70° 45,673'	Tucker Net ↑	308	163	14.9	6.7	1.870	1013.04	82	0
2a	341	Basic	2018-07-12	16:32	61° 57,863'	70° 45,987'	Monster Net ↓	310	159	12.2	6.5	1.602	1012.98	83	0
2a	341	Basic	2018-07-12	16:51	61° 57,788'	70° 45,736'	Monster Net ↑	309.7	158	10.7	5.9	1.670	1013.22	84	0
2a	341	Basic	2018-07-12	17:16	61° 57,498'	70° 45,370'	CTD Rosette ↓	309	154	10.5	5.5	2.935	1013.36	84	0
2a	341	Basic	2018-07-12	18:02	61° 57,538'	70° 45,025'	Agassiz Trawl ↓	308	143	9.3	5.8	3.392	1013.33	85	0
2a	341	Basic	2018-07-12	18:03	61° 57,182'	70° 44,608'	CTD Rosette ↑	307	165	14.7	5.9	2.957	1015.65	84	0
2a	341	Basic	2018-07-12	18:41	61° 57,105'	70° 45,379'	Agassiz Trawl ↑	310.51	142	11.2	6.1	2.554	1013.42	84	0
Leg 2b															
2b	1	Basic	2018-07-16	10:36	68° 21,636'	60° 26,269'	Monster Net ↓	882	30	14	1.5	-0.14	1000.90	100	1
2b	1	Basic	2018-07-16	12:51	68° 19,625'	60° 24,238'	PNF ↓	1595	27	17.9	0.2	-0.690	998.38	100	1
2b	1	Basic	2018-07-16	13:13	68° 19,221'	60° 24,276'	Barge ↓	1573.09	11	12.0	0.6	-0.700	998.33	100	1
2b	1	Basic	2018-07-16	13:51	68° 18,660'	60° 23,541'	CTD Rosette ↓	1584	22	19.4	0.2	-0.707	998.28	100	1
2b	1	Basic	2018-07-16	14:59	68° 18,154'	60° 24,557'	CTD Rosette ↑	1571.06	16	15.4	0.4	-0.633	998.70	100	1
2b	1	Basic	2018-07-16	15:14	68° 18,291'	60° 24,943'	Ice Sampling (cage) ↓	1573.54	9	15.6	0.2	-0.684	998.80	100	1
2b	1	Basic	2018-07-16	15:35	68° 18,139'	60° 25,517'	Ice Sampling (cage) ↑	1574.59	12	19.0	0.3	-0.583	998.85	100	1
2b	1	Basic	2018-07-16	15:48	68° 17,874'	60° 25,866'	Ice Sampling (cage) ↓	1575.72	4	12.9	0.2	-0.625	998.98	100	1
2b	1	Basic	2018-07-16	16:11	68° 17,673'	60° 26,704'	Ice Sampling (cage) ↑	1600	354	12.9	0.0	-0.677	999.19	100	1
2b	1	Basic	2018-07-16	16:58	68° 21,478'	60° 25,843'	Monster Net ↑	880	30	19	0.5	-0.05	1001.00	100	1
2b	1	Basic	2018-07-16	17:08	68° 17,212'	60° 29,396'	Barge ↑	1596.14	7	16.8	-0.1	-0.586	998.73	100	1
2b	Float deployn	Argo	2018-07-17	1:16	69° 17,481'	60° 43,904'	Argo Float ↓	1715.19	4	10.1	-0.5	-1.104	1001.16	100	0
2b	Float deployn	Argo	2018-07-17	1:29	69° 17,579'	60° 43,437'	Argo Float ↓	1753	2	10.5	-0.5	-1.077	1001.11	100	0
2b	Float deployn	Argo	2018-07-17	1:43	69° 17,534'	00° 00,000'	CTD Rosette ↓	2103	356	8.9	-0.5	-1.068	1001.12	100	
2b	Float deployn	Argo	2018-07-17	3:14	69° 17,508'	60° 42,616'	CTD Rosette ↑	1754	355	8.2	-0.8	-1.087	1001.02	100	1
2b	2	Basic	2018-07-17	10:24	68° 04,170'	61° 27,321'	Monster Net ↓	1685	332	17.3	-0.3	-1.270	1004.22	100	2
2b	2	Basic	2018-07-17	10:45	68° 04,019'	61° 27,351'	Monster Net ↑	1685	328	15.0	-0.1	-1.262	1004.95	100	2
2b	2	Basic	2018-07-17	12:25	68° 04,111'	61° 45,274'	Barge ↓	1672	338	17.3	-0.1	-1.22	1005.67	100	6
2b	2	Basic	2018-07-17	12:25	68° 02,466'	61° 27,764'	Barge ↓	1672	338	17.3	-0.1	-1.222	1005.67	100	6
2b	2	Basic	2018-07-17	12:35	68° 02,293'	61° 28,182'	PNF ↓	1679	340	18.0	-0.1	-1.067	1005.56	100	6
2b	2	Basic	2018-07-17	12:43	68° 01,375'	61° 16,909'	PNF ↓	1679	340	17.9	-0.1	-1.222	1005.84	100	6
2b	2	Basic	2018-07-17	12:54	68° 02,258'	61° 27,843'	CTD Rosette ↓	1680	333	16.6	-0.3	-1.228	1006.11	100	6
2b	2	Basic	2018-07-17	13:58	68° 01,486'	61° 28,039'	CTD Rosette ↑	1673	344	18.3	-0.5	-1.231	1006.24	100	6
2b	2	Basic	2018-07-17	14:18	68° 00,989'	61° 28,073'	accoustic Sensor ↓	1670	337	16.0	-0.6	-1.058	1007.41	100	6
2b	2	Basic	2018-07-17	15:01	68° 00,580'	61° 27,864'	accoustic Sensor ↑	1670	325	17.7	-0.6	-1.248	1007.88	100	6

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2b	2	Basic	2018-07-17	15:25	68° 00,261'	61° 29,016'	Barge ↑	1667.16	335	17.7	-0.4	-1.213	1007.58	100	6
2b	2	Ice	2018-07-17	15:58	67° 59,993'	61° 29,551'	Ice Sampling (cage) ↓	1670	333	21.5	-0.6	-1.164	1007.89	100	8
2b	2	Ice	2018-07-17	19:45	67° 57,820'	61° 33,960'	Ice Sampling (cage) ↑	1663	326	17.3	-1.1	-1.023	1009.18	100	7
2b	3	Basic	2018-07-18	10:17	67° 53,235'	62° 28,719'	Monster Net ↓	1083.94	273	6.7	-1.6	-1.321	1009.97	99	1
2b	3	Basic	2018-07-18	10:37	67° 53,151'	62° 28,409'	Monster Net ↑	1083.08	281	7.0	-1.2	-1.319	1014.18	99	1
2b	3	Basic	2018-07-18	12:15	67° 51,979'	62° 21,853'	PNF ↓	1088.73	301	7.8	-1.1	-1.252	1011.84	99	7
2b	3	Basic	2018-07-18	12:19	67° 51,958'	62° 21,754'	PNF ↑	1088.96	299	7.0	-0.4	-1.271	1011.93	99	7
2b	3	Basic	2018-07-18	12:30	67° 51,898'	62° 21,430'	Barge ↓	1092	305	6.7	-0.9	-1.258	1012.09	99	7
2b	3	Basic	2018-07-18	12:59	67° 52,018'	62° 21,401'	CTD Rosette ↓	1092	293	6.7	0.0	-1.216	1012.23	99	6
2b	3	Basic	2018-07-18	14:08	67° 51,688'	62° 20,043'	CTD Rosette ↑	1091	305	7.2	0.7	-1.087	1012.32	99	7
2b	3	Basic	2018-07-18	14:29	67° 51,631'	62° 19,794'	accoustic Sensor ↓	1092	315	7.2	0.6	-1.176	1012.33	99	7
2b	3	b	2018-07-18	15:15	67° 51,349'	62° 18,882'	accoustic Sensor ↑	1092	327	6.7	1.2	-0.913	1012.25	94	7
2b	3	Basic	2018-07-18	15:24	67° 51,251'	62° 18,630'	Barge ↑	1085.9	313	9.1	0.3	-0.904	1012.16	99	7
2b	3	Ice	2018-07-18	16:20	67° 48,558'	62° 18,909'	Ice Sampling (cage) ↓	1027	317	8.0	0.2	-1.240	1012.18	99	7
2b	3	Basic	2018-07-18	20:05	67° 47,367'	62° 20,825'	Ice Sampling (cage) ↑	988	334	7.0	0.2	-0.839	1012.34	99	7
2b	4	Basic	2018-07-19	11:22	67° 28,870'	63° 47,524'	Monster Net ↓	305	88	1.7	3.8	-0.596	1007.84	69	2
2b	4	Basic	2018-07-19	11:41	67° 28,883'	63° 47,367'	Monster Net ↑	337.55	214	0.8	3.7	-0.487	1007.65	69	3
2b	5	Basic	2018-07-19	12:06	67° 28,894'	63° 47,158'	PNF ↓	354	50	0.8	4.0	-0.515	1007.48	69	2
2b	5	Basic	2018-07-19	12:09	67° 28,898'	63° 47,102'	PNF ↑	355	60	2.7	3.4	-0.551	1007.45	71	2
2b	5	Basic	2018-07-19	12:23	67° 28,919'	63° 47,133'	CTD Rosette ↓	354	86	2.9	2.7	-0.613	1007.31	74	2
2b	5	Basic	2018-07-19	13:14	67° 28,915'	63° 46,537'	CTD Rosette ↑	356	163	1.0	3.4	-0.456	1006.57	73	2
2b	5	Basic	2018-07-19	13:26	67° 28,911'	63° 46,295'	accoustic Sensor ↓	356	67	1.3	3.7	-0.521	1006.39	71	2
2b	5	Basic	2018-07-19	14:15	67° 28,815'	63° 45,441'	accoustic Sensor ↑	355	329	2.3	3.4	-0.606	1006.11	74	2
2b	5	Basic	2018-07-19	14:20	67° 28,774'	63° 44,911'	Barge ↑	374.8	21	2.3	2.6	-0.596	1005.88	82	2
2b	5	Basic	2018-07-19	14:42	67° 28,766'	00° 00,000'	Barge ↓	375.83	16	1.9	2.7	-0.585	1005.83	82	2
2b	5	Basic	2018-07-19	19:30	67° 28,484'	63° 49,395'	Barge ↑	247.56	187	6.9	4.7	0.865	1003.51	73	1
2b	4	Basic	2018-07-21	10:18	67° 32,567'	00° 00,000'	Barge ↓	516.94	205	1.5	5.9	-0.614	1011.23	63	3
2b	4	Basic	2018-07-21	11:57	67° 32,491'	63° 34,136'	Monster Net ↓	489.89	194	5.1	4.0	-0.589	1011.14	71	6
2b	4	Basic	2018-07-21	12:16	67° 32,478'	63° 34,050'	Monster Net ↑	475.63	166	4.4	4.3	-0.592	1011.11	68	6
2b	4	Basic	2018-07-21	12:30	67° 32,464'	63° 33,965'	PNF ↓	472.29	185	4.4	4.5	-0.578	1011.12	66	6
2b	4	Basic	2018-07-21	12:35	67° 32,448'	63° 33,961'	PNF ↑	474.12	156	4.2	4.4	-0.563	1011.10	66	6
2b	4	Basic	2018-07-21	12:58	67° 32,423'	63° 33,805'	Barge ↑	451.57	144	4.0	4.4	-0.680	1011.11	67	6
2b	4	Basic	2018-07-21	13:22	67° 32,422'	63° 33,873'	CTD Rosette ↓	463.08	143	4.8	4.3	-0.483	1011.02	68	6
2b	4	Basic	2018-07-21	14:19	67° 32,193'	63° 33,646'	CTD Rosette ↑	447.54	132	6.7	3.8	-0.498	1010.89	71	6
2b	4	Basic	2018-07-21	15:09	67° 32,037'	63° 33,592'	Ice Sampling (cage) ↓	440.4	138	6.3	4.3	-0.423	1010.81	72	6
2b	4	Ice	2018-07-21	21:09	67° 32,934'	63° 35,154'	Ice Sampling (cage) ↑	565.24	147	9.7	4.9	-0.248	1011.11	68	8
2b	6	Basic	2018-07-22	10:40	67° 14,409'	64° 22,669'	Barge ↓	321.17	264	14.9	14.7	5.482	1013.90	47	0
2b	6	Basic	2018-07-22	11:32	67° 14,382'	64° 37,758'	Monster Net ↓	234.54	206	10.3	13.3	3.727	1014.32	44	0
2b	6	Basic	2018-07-22	11:45	67° 14,367'	64° 37,693'	Monster Net ↑	234.73	282	1.7	12.9	4.875	1014.53	49	0
2b	6	Basic	2018-07-22	11:49	67° 14,364'	64° 37,667'	PNF ↓	234.81	330	1.1	13.7	4.067	1014.54	44	0
2b	6	Basic	2018-07-22	11:53	67° 14,365'	64° 37,646'	PNF ↓	234.77	272	0.2	13.6	4.483	1014.65	43	0
2b	6	Basic	2018-07-22	12:00	67° 14,359'	64° 37,590'	PNF ↑	234.91	21	1.1	14.0	4.683	1014.68	44	0
2b	6	Basic	2018-07-22	12:42	67° 14,324'	64° 38,124'	CTD Rosette ↓	233.2	49	7.4	14.6	2.058	1014.98	51	0
2b	6	Basic	2018-07-22	13:17	67° 14,354'	64° 38,469'	CTD Rosette ↑	232.48	33	1.5	12.3	2.378	1015.17	61	0
2b	6	Basic	2018-07-22	13:29	67° 14,376'	64° 38,606'	Barge ↑	232.71	59	10.9	12.1	3.614	1015.28	60	0
2b	6	Basic	2018-07-22	13:49	67° 14,340'	64° 37,724'	Accoustic Sensor ↓	224	75	10.7	10.7	3.072	1015.47	67	0
2b	6	Basic	2018-07-22	14:20	67° 14,293'	64° 37,606'	Accoustic Sensor ↑	224	40	7.2	9.8	2.112	1015.87	73	0
2b	7	Basic	2018-07-23	16:37	64° 39,608'	59° 47,032'	Argo Float ↓	346.76	203	13.3	3.0	0.996	1005.81	85	1
Leg 2c															
2c	BELL-09	Coring	2018-07-25	6:05	63° 32,245'	68° 22,863'	Box Core ↓	88.62	5	5.3	8.6	5.3	1012.68	65	0
2c	BELL-09	Coring	2018-07-25	6:08	63° 32,242'	68° 22,861'	Box core (bottom)	88.79	13	5.0	8.3	5.0	1012.62	64	0
2c	BELL-09	Coring	2018-07-25	6:10	63° 32,236'	68° 22,854'	Box Core ↑	89.09	16	5.7	8.2	5.7	1012.57	64	0

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2c	BELL-10	Coring	2018-07-25	6:43	63° 35,643'	68° 20,068'	Box Core ↓	98.21	117	3.8	6.8	3.8	1012.29	70	0
2c	BELL-10	Coring	2018-07-25	6:45	63° 35,654'	68° 20,072'	Box core (bottom)	97.19	130	3.0	6.8	3.0	1012.30	69	0
2c	BELL-10	Coring	2018-07-25	6:47	63° 35,663'	68° 20,072'	Box Core ↑	96.07	110	2.1	7.0	2.1	1012.28	68	0
2c	Microplastics	Nutrient	2018-07-25	7:54	63° 39,687'	68° 32,333'	CTD Rosette ↓	72.66	125	5.9	7.0	5.9	1011.57	68	0
2c	Microplastics	Nutrient	2018-07-25	8:17	63° 39,752'	68° 32,403'	CTD Rosette ↑	66.62	140	5.5	7.0	0.856	1011.21	67	0
2c	Microplastics	Nutrient	2018-07-25	8:42	63° 38,812'	68° 31,326'	Surf Microplastics Trawling ↓	84.73	132	4.6	6.9	1.216	1011.10	71	0
2c	Microplastics	Nutrient	2018-07-25	9:13	63° 40,169'	68° 31,929'	Surf Microplastics Trawling ↑	635.6	103	3.4	7.2	1.635	1010.52	71	
2c	Microplastics	Nutrient	2018-07-25	9:25	63° 40,541'	68° 32,043'	Surf Microplastics Trawling ↓	58.5	160	8.9	6.9	1.459	1010.55	71	0
2c	Microplastics	Nutrient	2018-07-25	9:56	63° 40,229'	68° 35,148'	Surf Microplastics Trawling ↑	110.84	159	8.8	7.1	1.903	1010.23	66	0
2c	Microplastics	Nutrient	2018-07-25	10:06	63° 40,210'	68° 35,886'	Surf Microplastics Trawling ↓	134.86	156	11.2	7.4	1.483	1010.28	65	0
2c	Microplastics	Nutrient	2018-07-25	10:37	63° 38,867'	68° 35,260'	Surf Microplastics Trawling ↑	200.82	149	13.7	7.7	1.511	1009.90	65	0
2c	Microplastics	Nutrient	2018-07-25	10:45	63° 38,515'	68° 35,197'	Surf Microplastics Trawling ↓	153.35	133	12.6	8.1	1.360	1009.82	63	0
2c	Microplastics	Nutrient	2018-07-25	11:16	63° 38,796'	68° 32,084'	Surf Microplastics Trawling ↑	85.87	128	10.5	5.8	1.847	1009.93	74	0
2c	11c	Basic	2018-07-25	17:17	63° 09,897'	67° 33,082'	Drop camera ↓	371	138	12.6	7.1	2.306	1007.52	71	0
2c	11c	Basic	2018-07-25	17:24	63° 09,915'	67° 33,078'	Drop camera (bottom)start	378	144	11.0	6.8	2.928	1007.57	72	0
2c	11c	Basic	2018-07-25	17:40	63° 09,981'	67° 33,238'	Drop camera (bottom)end	381	128	8.6	6.5	2.441	1007.45	74	0
2c	11c	Basic	2018-07-25	17:46	63° 10,020'	67° 33,324'	Drop camera ↑	381	125	8.0	6.4	2.400	1007.43	74	0
2c	11c	Basic	2018-07-25	18:37	63° 09,893'	67° 32,954'	Agassiz Trawl ↓	353.04	134	6.3	8.3	2.292	1006.83	68	0
2c	11c	Basic	2018-07-25	19:12	63° 09,643'	67° 33,523'	Agassiz Trawl ↑	441.16	128	5.0	8.0	2.954	1006.24	68	0
2c	11c	Basic	2018-07-25	19:41	63° 09,906'	67° 33,108'	Box Core ↓	373.42	158	9.7	7.5	3.618	1005.80	71	0
2c	11c	Basic	2018-07-25	19:48	63° 09,916'	67° 33,117'	Box core (bottom)	369.72	162	9.7	7.4	3.356	1005.62	72	0
2c	11c	Basic	2018-07-25	19:55	63° 09,970'	67° 33,114'	Box Core ↑	328.57	165	10.7	8.2	3.438	1005.49	67	0
2c	Outer Bay A	Nutrient	2018-07-25	21:03	63° 07,655'	67° 26,341'	CTD Rosette ↓	339.83	156	10.5	10.0	3.145	1005.01	60	0
2c	Outer Bay A	Nutrient	2018-07-25	21:26	63° 07,754'	67° 26,438'	CTD Rosette ↑	328.26	154	12.0	10.3	3.635	1004.61	58	
2c	Outer Bay A	Nutrient	2018-07-25	22:07	63° 07,955'	67° 26,439'	Surf Microplastics Trawling ↓	288.98	133	7.0	5.1	3.516	1004.55	85	
2c	Outer Bay A	Nutrient	2018-07-25	22:38	63° 06,562'	67° 26,170'	Surf Microplastics Trawling ↑	299.38	157	9.7	7.2	3.147	1004.22	73	0
2c	12c	Basic	2018-07-25	23:00	63° 04,896'	67° 25,720'	CTD Rosette ↓	346.67	143	8.6	6.9	2.240	1004.07	73	0
2c	12c	Basic	2018-07-25	23:24	63° 04,855'	67° 25,411'	CTD Rosette ↓	355.44	195	6.5	11.2	1.819	1003.89	54	0
2c	12c	Basic	2018-07-26	0:17	63° 04,861'	67° 25,514'	Drop camera ↓	350	274	7.8	15.4	2.484	1003.89	45	0
2c	12c	Basic	2018-07-26	0:29	63° 04,828'	67° 25,095'	Drop camera (bottom)start	375	247	8.8	14.5	2.635	1003.75	47	
2c	12c	Basic	2018-07-26	0:48	63° 04,762'	67° 24,385'	Drop camera (bottom)end	350	252	7.6	13.0	2.755	1003.94	52	0
2c	12C	Basic	2018-07-26	0:54	63° 04,741'	67° 24,171'	Drop camera ↑	350	244	6.9	12.3	2.862	1004.01	53	0
2c	12C	Basic	2018-07-26	1:24	63° 04,897'	67° 25,893'	Box Core ↓	339	260	4.2	12.2	2.801	1003.89	55	0
2c	12C	Basic	2018-07-26	1:29	63° 04,866'	67° 25,678'	Box core (bottom)	345	255	6.7	12.2	2.283	1003.89	55	0
2c	12C	Basic	2018-07-26	1:37	63° 04,849'	67° 25,453'	Box Core ↑	350	254	8.8	13.4	2.807	1003.74	51	0
2c	2A	Basic	2018-07-26	3:06	62° 58,927'	67° 22,591'	Drop camera ↓	630	276	12.4	14.0	2.580	1003.14	48	0
2c	2A	Basic	2018-07-26	3:19	62° 58,983'	67° 22,087'	Drop camera (bottom)start	627	199	15.4	15.5	3.002	1002.87	44	0
2c	2A	Basic	2018-07-26	3:36	62° 59,084'	67° 21,483'	Drop camera (bottom)end	692	231	7.8	15.1	3.050	1002.87	44	0
2c	2A	Basic	2018-07-26	3:49	62° 59,122'	67° 21,290'	Drop camera ↑	692	234	2.3	15.0	2.937	1002.87	45	0
2c	2A	Basic	2018-07-26	4:16	62° 58,853'	00° 00,000'	Box Core ↓	595	302	15.6	14.4	2.758	1002.70	46	0
2c	2A	Basic	2018-07-26	4:28	62° 58,861'	67° 22,340'	Box core (bottom)	596	296	18.3	14.5	2.185	1002.45	45	0
2c	2A	Basic	2018-07-26	4:39	62° 58,928'	67° 22,249'	Box Core ↑	589	257	17.9	14.5	2.402	1002.47	47	0
2c	13c	Basic	2018-07-26	8:10	62° 41,199'	66° 46,348'	CTD Rosette ↓	214	253	15.6	14.5	2.787	1001.40	46	0
2c	13c	Basic	2018-07-26	8:27	62° 41,188'	66° 46,540'	CTD Rosette ↑	211	271	15.2	14.3	2.670	1001.33	45	0
2c	13c	Basic	2018-07-26	9:18	62° 41,165'	66° 46,182'	Drop camera ↓	220	271	17.1	14.3	2.063	1000.89	47	0
2c	13c	Basic	2018-07-26	9:48	62° 41,152'	66° 46,391'	Drop camera ↑	220	284	13.1	14.2	2.137	1001.06	48	0
2c	13c	Basic	2018-07-26	10:11	62° 41,192'	66° 46,226'	Box Core ↓	204	291	11.0	14.2	2.275	1001.14	49	0
2c	13c	Basic	2018-07-26	10:17	62° 41,187'	66° 46,203'	Box core (bottom)	206	282	8.0	13.9	2.305	1001.03	50	0
2c	13c	Basic	2018-07-26	10:21	62° 41,182'	66° 46,162'	Box Core ↑	206	266	9.3	13.9	2.296	1001.09	50	0
2c	13c	Basic	2018-07-26	10:22	62° 41,183'	66° 46,160'	Box Core ↓	208	276	9.7	13.7	2.314	1001.11	50	0
2c	13c	Basic	2018-07-26	10:26	62° 41,201'	66° 46,182'	Box core (bottom)	205	250	8.6	13.8	2.607	1001.14	51	0
2c	13c	Basic	2018-07-26	10:31	62° 41,222'	66° 46,221'	Box Core ↑	198	274	13.1	13.8	2.743	1001.06	52	0

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2c	13c	Basic	2018-07-26	10:35	62° 41,208'	66° 46,248'	Box Core ↓	205	274	10.5	14.0	2.804	1001.04	52	0
2c	13c	Basic	2018-07-26	10:41	62° 41,174'	66° 46,212'	Box core (bottom)	225	320	5.7	13.8	2.528	1001.25	53	0
2c	13c	Basic	2018-07-26	10:46	62° 41,144'	66° 46,223'	Box Core ↑	230	108	3.8	11.7	2.403	1001.51	63	0
2c	13c	Basic	2018-07-26	11:12	62° 41,241'	66° 46,256'	Surf Microplastics Trawling ↓	193	101	4.2	8.6	2.870	1001.55	69	0
2c	13c	Basic	2018-07-26	11:42	62° 42,305'	66° 44,888'	Surf Microplastics Trawling ↑	569	71	5.3	8.7	2.868	1001.58	76	0
2c	20D	Basic	2018-07-26	12:48	62° 50,657'	66° 35,637'	Rosette ↓	141	183	0.2	7.3	1.931	1001.62	87	0
2c	20D	Basic	2018-07-26	13:06	62° 50,541'	66° 35,677'	Rosette ↑	219.91	360	1.9	7.5	2.083	1001.57	87	0
2c	20D	Basic	2018-07-26	13:23	62° 50,641'	66° 35,374'	Drop camera ↓	111.34	306	8.6	6.8	2.003	1001.68	89	0
2c	20D	Basic	2018-07-26	13:27	62° 50,646'	66° 35,340'	Drop camera (bottom)start	107.72	301	7.4	6.8	2.122	1001.70	88	0
2c	20d	Basic	2018-07-26	13:37	62° 50,648'	66° 35,234'	Drop camera (bottom)end	112.63	268	5.3	5.8	2.211	1001.74	91	0
2c	20D	Basic	2018-07-26	13:39	62° 50,652'	66° 35,215'	Drop camera ↑	113.93	282	5.9	5.4	2.214	1001.78	93	0
2c	20D	Basic	2018-07-26	13:59	62° 50,679'	66° 35,316'	Box Core ↓	107.58	247	3.0	6.2	1.236	1001.63	91	0
2c	20D	Basic	2018-07-26	14:03	62° 50,673'	66° 35,323'	Box core (bottom)	112.76	282	4.0	6.4	1.251	1001.65	90	0
2c	20D	Basic	2018-07-26	14:04	62° 50,672'	66° 35,327'	Box Core ↑	113.78	261	3.4	6.6	1.285	1001.64	89	0
2c	20D	Basic	2018-07-26	14:06	62° 50,671'	66° 35,330'	Box Core ↓	112.68	289	2.5	6.9	1.477	1001.66	88	0
2c	20D	Basic	2018-07-26	14:08	62° 50,671'	66° 35,333'	Box core (bottom)	112.56	258	4.8	6.7	1.694	1001.70	89	0
2c	20D	Basic	2018-07-26	14:11	62° 50,670'	66° 35,335'	Box Core ↑	113.13	266	4.8	6.7	1.821	1001.62	90	0
2c	20D	Basic	2018-07-26	14:25	62° 50,633'	66° 35,335'	Box Core ↓	152.69	270	4.0	6.6	2.493	1001.64	90	0
2c	20D	Basic	2018-07-26	14:28	62° 50,637'	66° 35,341'	Box core (bottom)	151.29	259	1.1	6.8	2.418	1001.58	88	0
2c	20D	Basic	2018-07-26	14:31	62° 50,648'	66° 35,352'	Box Core ↑	140.41	333	1.1	7.0	2.448	1001.60	88	0
2c	20D	Basic	2018-07-26	14:53	62° 50,652'	66° 35,213'	Agassiz Trawl ↓	113.16	272	13.3	5.9	1.685	1001.72	90	0
2c	20D	Basic	2018-07-26	15:06	62° 50,977'	66° 35,013'	Agassiz Trawl ↑	139.07	280	11.4	5.1	2.189	1001.87	91	0
2c	7b	Basic	2018-07-26	16:27	62° 44,020'	66° 34,409'	Box Core ↓	446.4	312	11.4	4.2	2.468	1002.60	90	0
2c	7b	Basic	2018-07-26	16:36	62° 44,007'	66° 34,388'	Box core (bottom)	445.2	306	13.5	4.2	2.512	1002.63	90	0
2c	7b	Basic	2018-07-26	16:43	62° 44,014'	66° 34,402'	Box Core ↑	445.87	315	12.2	4.4	2.395	1002.79	89	0
2c	4a	Basic	2018-07-26	18:06	62° 47,109'	66° 51,702'	Surf Microplastics Trawling ↓	460.92	314	19.6	4.3	2.025	1002.69	79	0
2c	4a	Basic	2018-07-26	18:09	62° 47,056'	66° 51,415'	Surf Microplastics Trawling ↑	504.39	316	16.6	4.4	2.197	1002.90	79	0
2c	9b	Basic	2018-07-26	21:09	62° 40,627'	66° 29,303'	CTD Rosette ↓	485.33	330	23.0	5.2	2.144	1003.99	67	0
2c	9b	Basic	2018-07-26	22:04	62° 40,450'	66° 29,440'	CTD Rosette ↑	496	324	26.1	5.2	1.830	1004.40	67	0
2c	9b	Basic	2018-07-26	23:14	62° 40,547'	66° 29,542'	Drop camera ↓	484	322	25.7	5.1	2.311	1004.81	65	0
2c	9b	Basic	2018-07-26	23:27	62° 40,511'	66° 29,447'	Drop camera (bottom)Start	498	322	25.7	5.3	2.326	1004.84	63	0
2c	9B	Basic	2018-07-26	23:57	62° 40,416'	66° 29,293'	Drop camera (bottom)end	500	308	19.2	4.9	2.471	1005.39	66	0
2c	9B	Basic	2018-07-27	0:05	62° 40,401'	66° 29,280'	Drop camera ↑	491.73	304	16.8	4.8	2.452	1005.73	67	0
2c	10B	Basic	2018-07-27	0:45	62° 39,392'	66° 24,000'	Drop camera ↓	405	299	17.5	4.4	2.185	1006.03	71	0
2c	10B	Basic	2018-07-27	0:52	62° 39,355'	66° 23,971'	Drop camera (bottom)start	385	302	14.7	4.3	2.190	1006.29	72	0
2c	10B	Basic	2018-07-27	1:10	62° 39,334'	66° 23,890'	Drop camera (bottom)end	402.03	300	16.6	4.2	2.247	1006.36	72	0
2c	10B	Basic	2018-07-27	1:17	62° 39,331'	66° 23,878'	Drop camera ↑	402.03	302	16.0	4.3	2.231	1006.43	71	0
2c	15C	Basic	2018-07-27	3:19	62° 25,859'	65° 53,232'	Drop camera ↓	328.59	323	17.5	3.6	1.013	1007.29	76	0
2c	15C	Basic	2018-07-27	3:27	62° 25,876'	65° 53,127'	Drop camera (bottom)start	328.59	318	19.8	3.7	1.043	1007.17	77	0
2c	15C	Basic	2018-07-27	3:42	62° 25,853'	65° 52,974'	Drop camera (bottom)end	328.59	325	18.7	3.6	1.061	1007.54	78	0
2c	15C	Basic	2018-07-27	3:47	62° 25,851'	65° 52,894'	Drop camera ↑	328.59	317	20.8	3.4	1.068	1007.50	79	0
2c	15C	Basic	2018-07-27	4:25	62° 25,862'	65° 53,700'	Surf Microplastics Trawling ↓	338.21	1	0.6	3.4	1.225	1008.03	82	0
2c	15C	Basic	2018-07-27	4:56	62° 24,545'	65° 54,819'	Surf Microplastics Trawling ↑	388.38	311	18.1	3.2	0.994	1008.03	82	0
2c	15C	Basic	2018-07-27	5:24	62° 25,879'	65° 53,857'	Surf Microplastics Trawling ↓	338.49	312	11.6	3.3	1.204	1008.53	82	0
2c	15C	Basic	2018-07-27	5:55	62° 24,626'	65° 55,134'	Surf Microplastics Trawling ↑	389.12	313	14.5	2.9	1.283	1008.63	82	0
2c	Sponge site 5	Nutrient	2018-07-27	19:35	60° 24,026'	62° 54,006'	CTD Rosette ↓	300.96	336	5.5	4.5	1.681	1014.60	81	1
2c	Sponge site 5	Nutrient	2018-07-27	20:24	60° 24,097'	62° 53,979'	CTD Rosette ↑	301.65	298	7.0	3.7	2.632	1014.90	86	0
2c	Non-Sponge	Nutrient	2018-07-28	3:04	59° 13,478'	61° 49,575'	CTD Rosette ↓	150.68	181	4.4	3.6	3.937	1016.79	97	0
2c	Non-Sponge	Nutrient	2018-07-28	3:41	59° 13,513'	61° 49,535'	CTD Rosette ↑	150.36	190	5.7	3.7	3.481	1016.88	96	0
2c	Non-Sponge	Nutrient	2018-07-28	6:06	59° 18,671'	61° 01,030'	CTD Rosette ↓	205.54	23	2.3	2.6	1.857	1016.65	99	0
2c	Non-Sponge	Nutrient	2018-07-28	6:51	59° 18,483'	61° 00,380'	CTD Rosette ↑	203.64	145	3.8	2.0	1.660	1016.61	99	0
2c	Non-Sponge	ROV	2018-07-28	9:43	59° 22,943'	60° 16,060'	CTD Rosette ↓	601.7	332	0.0	4.1	3.183	1017.16	92	0

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2c	Non-Sponge S	ROV	2018-07-28	10:24	59° 23,049'	60° 16,237'	CTD Rosette ↑	600.32	219	5.5	3.6	3.123	1017.20	93	0
2c	Non-Sponge S	ROV	2018-07-28	12:43	59° 22,904'	60° 16,685'	ROV ↓	545	213	1.9	3.8	3.479	1017.79	93	0
2c	Non-Sponge S	ROV	2018-07-28	13:10	59° 22,903'	60° 16,687'	ROV (bottom)Start	545	215	3.0	3.8	3.327	1017.88	92	0
2c	Non-Sponge S	ROV	2018-07-28	14:17	59° 22,915'	60° 16,611'	ROV (bottom)END	545	176	6.3	3.9	3.764	1017.71	92	0
2c	Non-Sponge S	ROV	2018-07-28	14:40	59° 22,873'	60° 16,523'	ROV ↑	545	164	5.3	3.8	3.604	1017.79	93	0
2c	Non-Sponge S	ROV	2018-07-28	16:14	59° 22,858'	60° 16,606'	Drop camera ↓	546	194	6.5	3.7	4.216	1017.62	95	0
2c	Non-Sponge S	ROV	2018-07-28	16:25	59° 22,840'	60° 16,602'	Drop camera (bottom)start	546	197	5.9	3.4	3.992	1017.63	96	0
2c	Non-Sponge S	ROV	2018-07-28	17:11	59° 22,623'	60° 16,803'	Drop camera (bottom)end	546	183	7.2	3.2	3.576	1017.61	95	0
2c	Non-Sponge S	ROV	2018-07-28	17:21	59° 22,574'	60° 16,844'	Drop camera ↑		188	7.0	3.2	3.763	1017.52	95	0
2c	Non-Sponge S	ROV	2018-07-28	19:07	59° 22,882'	60° 16,701'	Lander ↓	547.74	108	0.0	4.5	3.297	1017.47	88	0
2c	Non-Sponge S	ROV	2018-07-28	19:52	59° 22,897'	60° 16,729'	Lander (bottom)↓	547.76	226	0.6	3.4	3.447	1017.27	97	0
2c	Non-Sponge S	Nutrient	2018-07-28	23:20	59° 28,492'	59° 26,547'	CTD Rosette ↓	1961	169	7.4	2.9	4.718	1017.37	100	0
2c	Non-Sponge S	Nutrient	2018-07-29	1:09	59° 28,650'	59° 27,490'	CTD Rosette ↑	1961	131	8.2	3.3	4.715	1017.23	100	0
2c	Non-Sponge S	Nutrient	2018-07-29	4:20	59° 32,024'	58° 38,044'	CTD Rosette ↓	2378.36	148	9.1	3.1	5.034	1017.77	100	0
2c	Non-Sponge S	Nutrient	2018-07-29	6:39	59° 32,069'	58° 38,881'	CTD Rosette ↑	2521.66	150	10.7	3.4	5.077	1017.44	100	0
2c	Saglek bank (	ROV	2018-07-29	16:50	60° 27,178'	61° 15,380'	CTD Rosette ↓	516.57	139	16.2	4.0	2.261	1011.55	100	
2c	Saglek bank (	ROV	2018-07-29	17:24	60° 26,942'	61° 14,799'	CTD Rosette ↑	554.97	153	17.3	4.1	2.329	1011.41	100	0
2c	Saglek bank (	ROV	2018-07-29	18:26	60° 27,874'	61° 15,865'	ROV ↓	514	175	8.2	4.6	2.270	1011.30	100	0
2c	Saglek bank (	ROV	2018-07-29	19:08	60° 27,850'	61° 15,818'	ROV (bottom)Start	514	140	15.2	4.1	2.275	1011.18	100	0
2c	Saglek bank (	ROV	2018-07-29	20:17	60° 27,890'	61° 15,593'	ROV (bottom)End	514	139	14.9	3.9	2.291	1011.02	100	0
2c	Saglek bank (	ROV	2018-07-29	20:38	60° 27,969'	61° 15,628'	ROV ↑	514	133	13.9	3.9	2.111	1011.02	100	0
2c	DFO-1	Full	2018-07-29	22:39	60° 27,807'	61° 15,869'	CTD Rosette ↓	506.5	160	15.4	3.6	1.962	1010.20	100	0
2c	DFO-1	Full	2018-07-29	23:36	60° 27,870'	61° 16,317'	CTD Rosette ↑	479.08	112	4.2	3.4	1.896	1010.13	100	0
2c	DFO-1	Full	2018-07-29	23:57	60° 27,790'	61° 15,752'	Net Phyto ↓	511.96	156	17.9	3.3	1.931	1009.99	100	
2c	DFO-1	Full	2018-07-30	0:02	60° 27,791'	61° 15,779'	Net Phyto ↑	510.1	150	16.0	3.3	2.201	1010.15	100	
2c	DFO-1	Full	2018-07-30	0:25	60° 27,758'	61° 15,876'	HydroBios ↓	500.31	144	17.5	3.1	1.998	1009.82	100	
2c	DFO-1	Full	2018-07-30	0:53	60° 27,735'	61° 16,236'	Hydrobios ↑	465.22	145	17.5	3.0	2.017	1009.62	100	0
2c	DFO-1	Full	2018-07-30	1:14	60° 27,812'	61° 15,507'	WBAT ↓	532.22	147	18.7	3.0	2.118	1010.43	100	0
2c	DFO-1	Full	2018-07-30	2:05	60° 27,656'	61° 15,999'	WBAT ↑	538	146	20.0	3.1	2.340	1010.31	100	0
2c	Sponge site 4	Nutrient	2018-07-30	7:25	60° 27,580'	62° 07,227'	CTD Rosette ↓	368	142	18.7	2.6	1.633	1008.19	100	0
2c	Sponge site 4	Nutrient	2018-07-30	8:11	60° 27,428'	62° 05,860'	CTD Rosette ↑	364.63	138	20.4	2.5	1.621	1007.65	100	0
2c	Sponge Site 3	ROV	2018-07-30	10:50	60° 28,147'	61° 17,255'	ROV ↓	400	129	15.6	2.7	2.239	1007.85	100	0
2c	Sponge Site 3	ROV	2018-07-30	10:59	60° 28,157'	61° 17,215'	ROV ↑	400	123	12.8	2.9	2.268	1007.91	100	0
2c	Sponge Site 3	ROV	2018-07-30	13:17	60° 28,106'	61° 17,280'	Lander ↓	405	143	15.4	3.4	2.488	1007.45	100	0
2c	Sponge Site 3	ROV	2018-07-30	13:51	60° 28,036'	61° 17,567'	LANDER ↑	405	149	16.9	3.6	2.614	1007.48	101	0
2c	Sponge Site 3	ROV	2018-07-30	14:10	60° 28,048'	61° 17,377'	Lander ↓	405	154	15.2	3.5	2.687	1007.39	100	0
2c	Sponge Site 3	ROV	2018-07-30	14:31	60° 28,042'	61° 17,270'	Lander (bottom)↓	405	127	15.6	3.5	2.687	1007.03	100	0
2c	Sponge Site 3	ROV	2018-07-30	15:19	60° 28,043'	61° 17,592'	Rosette ↓	400	143	15.8	3.9	2.808	1006.70	100	0
2c	Sponge Site 3	ROV	2018-07-30	15:58	60° 28,026'	61° 18,090'	CTD Rosette ↑	404.28	144	15.2	3.2	2.807	1005.38	100	0
2c	DFO-3	Full	2018-07-30	18:53	60° 28,230'	61° 05,699'	IKMT ↓	1161.98	144	14.1	4.0	3.215	1005.95	100	0
2c	DFO-3	Full	2018-07-30	20:52	60° 24,525'	61° 07,766'	IKMT ↑	955.3	148	16.9	3.3	2.723	1003.50	101	0
2c	DFO-3	Full	2018-07-30	21:37	60° 28,051'	61° 05,453'	WBAT ↓	1250	157	17.9	3.7	3.568	1005.26	100	0
2c	DFO-3	Full	2018-07-30	22:35	60° 27,622'	61° 04,796'	WBAT ↑	1146.24	161	18.5	3.5	3.515	1003.85	100	0
2c	DFO-3	Full	2018-07-30	22:56	60° 28,166'	61° 06,012'	Net Phyto ↓	1258	165	16.4	3.4	3.484	1003.63	101	0
2c	DFO-3	Full	2018-07-30	23:00	60° 28,127'	61° 05,986'	Net Phyto ↑	1152.39	171	17.5	3.5	3.544	1003.61	101	
2c	DFO-3	Full	2018-07-30	23:19	60° 27,863'	61° 05,953'	HydroBios ↓	1136.09	169	16.9	3.4	3.448	1003.51	101	0
2c	DFO-3	Full	2018-07-31	0:15	60° 27,618'	61° 06,807'	Hydrobios ↑	1066.47	162	19.2	3.4	3.399	1003.43	100	0
2c	DFO-3	Full	2018-07-31	0:58	60° 27,977'	61° 06,246'	CTD Rosette ↓	1138.11	174	20.0	3.7	3.889	1003.59	101	0
2c	DFO-3	Full	2018-07-31	2:02	60° 27,859'	61° 07,015'	CTD Rosette ↑	1111.51	171	18.7	3.8	4.172	1003.87	101	0
2c	DFO-3	Full	2018-07-31	2:36	60° 28,165'	61° 05,985'	Drop camera ↓	1166	172	16.6	4.0	4.582	1003.57	101	0
2c	DFO-3	Full	2018-07-31	2:57	60° 28,150'	61° 06,334'	Drop camera (bottom)start	1166	167	15.8	3.8	4.677	1003.42	101	0
2c	DFO-3	Full	2018-07-31	3:28	60° 28,146'	61° 06,613'	Drop camera (bottom)end	1166	164	19.0	4.0	4.557	1003.06	101	0

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2c	DFO-3	Full	2018-07-31	3:47	60° 28,104'	61° 06,609'	Drop camera ↑	1133.31	161	18.3	4.2	4.442	1003.18	101	0
2c	DFO-3	Full	2018-07-31	4:21	60° 28,157'	61° 05,647'	Box Core ↓	1160.04	174	15.4	4.2	4.370	1003.20	101	0
2c	DFO-3	Full	2018-07-31	4:45	60° 28,174'	61° 05,581'	Box core (bottom)	1162.29	163	16.9	4.1	4.576	1003.06	101	0
2c	DFO-3	Full	2018-07-31	5:07	60° 28,159'	61° 05,469'	Box Core ↑	1164.23	166	14.5	4.2	4.506	1002.98	101	0
2c	Saglek Deep (	ROV	2018-07-31	11:09	60° 27,990'	61° 09,835'	ROV ↓	1058	170	8.0	2.9	3.024	1003.50	101	0
2c	Saglek Deep (	ROV	2018-07-31	13:50	60° 27,977'	61° 09,852'	ROV ↑	1058	213	5.5	2.4	3.330	1004.40	101	0
2c	HiBio-A-2017	Mooring	2018-07-31	15:10	60° 27,501'	61° 15,750'	Mooring ↑	977.8	272	6.5	1.7	2.543	1004.24	101	0
2c	DFO-750	Full	2018-07-31	16:53	60° 28,270'	61° 13,121'	Drop camera ↓	770	293	12.6	2.0	3.359	1004.26	101	0
2c	DFO-750	Full	2018-07-31	17:14	60° 28,269'	61° 13,031'	Drop camera (bottom)start	770	289	14.1	2.3	3.371	1004.47	101	0
2c	DFO-750	Full	2018-07-31	18:15	60° 28,172'	61° 12,342'	Drop camera (bottom)end	770	289	14.7	1.9	3.539	1004.44	100	0
2c	DFO-750	Full	2018-07-31	18:31	60° 28,137'	61° 12,211'	Drop camera ↑	817.41	284	18.3	1.9	3.588	1004.69	100	0
2c	DFO-750	Full	2018-07-31	19:01	60° 28,223'	61° 13,055'	IKMT ↓	754.82	290	14	2.4	3.665	1007.83	101	0
2c	DFO-750	Full	2018-07-31	20:15	60° 27,967'	61° 09,522'	IKMT ↑	1004.84	281	15.2	1.9	4.035	1005.81	100	0
2c	DFO-750	Full	2018-07-31	20:41	60° 28,128'	61° 12,892'	WBAT ↓	763	283	16.8	1.7	1.954	1005.61	100	
2c	DFO-750	Full	2018-07-31	21:35	60° 27,092'	61° 11,100'	WBAT ↑	763	304	20.9	2.4	2.033	1006.45	100	0
2c	DFO-750	Full	2018-07-31	22:01	60° 28,293'	61° 13,267'	Net Phyto ↓	731.25	311	22.8	2.5	2.005	1006.18	100	0
2c	DFO-750	Full	2018-07-31	22:06	60° 28,174'	61° 13,066'	Net Phyto ↑	748.83	302	18.3	2.4	1.929	1006.17	100	0
2c	DFO-750	Full	2018-07-31	22:27	60° 28,076'	61° 13,157'	HydroBios ↓	737.8	302	23.0	2.6	1.855	1006.85	100	0
2c	DFO-750	Full	2018-07-31	23:08	60° 27,512'	61° 13,288'	Hydrobios ↑	717.07	311	18.3	2.2	1.839	1006.95	100	0
2c	DFO-750	Full	2018-07-31	23:37	60° 28,033'	61° 13,063'	CTD Rosette ↓	744.11	309	15.2	2.0	2.003	1006.68	100	0
2c	DFO-750	Full	2018-08-01	0:24	60° 27,452'	61° 13,477'	CTD Rosette ↑	682.68	302	14.1	1.9	2.028	1006.79	100	0
2c	DFO-750	Full	2018-08-01	0:58	60° 28,148'	61° 13,376'	Agassiz Trawl ↓	722.66	299	14.3	2.1	2.257	1006.98	100	0
2c	DFO-750	Full	2018-08-01	1:18	60° 27,616'	61° 13,789'	Agassiz Trawl ↑	655.28	317	7.2	2.3	2.234	1007.25	100	0
2c	DFO-750	Full	2018-08-01	1:31	60° 27,384'	61° 13,433'	Agassiz Trawl ↓	682.21	277	11.2	1.8	2.391	1007.21	100	0
2c	DFO-750	Full	2018-08-01	2:34	60° 28,864'	61° 12,567'	Agassiz Trawl ↑	799.11	261	15.0	1.9	3.070	1008.25	100	0
2c	18-DFO-RIDG	Other	2018-08-01	12:15	60° 27,304'	61° 07,658'	Drop camera ↓	1009	266	16.8	2.1	2.600	1009.99	92	0
2c	18-DFO-RIDG	Other	2018-08-01	12:41	60° 27,304'	61° 07,557'	Drop camera ↑	1009	262	15.6	2.2	3.001	1011.04	92	0
2c	18-DFO-RIDG	Other	2018-08-01	12:51	60° 27,281'	61° 07,765'	Drop camera ↓	1009	251	13.3	2.2	3.019	1011.58	92	0
2c	18-DFO-RIDG	Other	2018-08-01	13:15	60° 27,272'	61° 07,614'	Drop camera ↑	1009	266	12.4	2.2	3.155	1012.40	92	0
2c	18-DFO-RIDG	Other	2018-08-01	14:30	60° 27,288'	61° 07,687'	Drop camera ↓	978	257	11.6	2.4	3.356	1010.58	92	0
2c	18-DFO-RIDG	Other	2018-08-01	14:58	60° 27,270'	61° 07,701'	Drop camera (bottom)start	978	253	13.9	2.8	3.445	1010.51	91	0
2c	18-DFO-RIDG	Other	2018-08-01	15:29	60° 27,180'	61° 07,657'	Drop camera (bottom)end	978	252	11.4	2.9	3.667	1010.52	90	0
2c	18-DFO-RIDG	Other	2018-08-01	15:41	60° 27,178'	61° 07,685'	Drop camera ↑	956.55	252	13.5	3.0	3.812	1010.44	90	0
2c	DFO-3	Mooring	2018-08-01	17:21	60° 27,843'	61° 09,544'	Mooring ↓	999.99	227	9.9	3.3	1.941	1010.89	89	0
2c	DFO-750	ROV	2018-08-01	19:34	60° 26,025'	61° 11,863'	ROV ↓	750	217	12.0	4.1	1.875	1010.90	82	0
2c	DFO-750	ROV	2018-08-01	20:30	60° 26,025'	61° 11,854'	ROV (bottom)Start	755	208	12.9	3.7	1.657	1010.82	86	0
2c	DFO-750	ROV	2018-08-01	21:42	60° 25,946'	61° 12,656'	ROV (bottom)End	755	206	12.9	3.6	1.510	1010.53	89	0
2c	DFO-750	ROV	2018-08-01	22:16	60° 25,777'	61° 12,627'	ROV ↑	669.17	206	14.3	3.6	1.528	1010.61	88	0
2c	DFO-5	Full	2018-08-02	0:19	60° 28,012'	60° 35,862'	CTD Rosette ↓	1416.52	227	13.9	5.0	4.938	1011.33	86	0
2c	DFO-5	Full	2018-08-02	1:22	60° 27,511'	60° 36,650'	CTD Rosette ↑	1403.33	223	15.6	5.0	5.055	1011.01	87	0
2c	DFO-5	Full	2018-08-02	1:54	60° 27,992'	60° 36,288'	Net Phyto ↓	1414.6	215	14.9	4.9	5.248	1010.92	87	0
2c	DFO-5	Full	2018-08-02	2:00	60° 27,991'	60° 36,409'	Net Phyto ↑	1413.36	221	14.1	4.8	5.243	1010.82	88	0
2c	DFO-5	Full	2018-08-02	2:15	60° 27,855'	60° 36,674'	HydroBios ↓	1408.79	225	16.6	4.8	5.252	1010.74	87	0
2c	DFO-5	Full	2018-08-02	3:18	60° 26,886'	60° 37,596'	Hydrobios ↑	1381.89	209	7.8	5.7	5.196	1010.77	86	0
2c	DFO-5	Full	2018-08-02	3:21	60° 26,837'	60° 37,665'	HydroBios ↓	1380.31	7	0.6	5.3	5.175	1010.88	86	0
2c	DFO-5	Full	2018-08-02	4:27	60° 26,523'	60° 38,308'	Hydrobios ↑	1354.77	22	2.1	5.4	5.132	1010.51	87	0
2c	DFO-5	Full	2018-08-02	4:59	60° 28,152'	60° 36,063'	WBAT ↓	1438	174	4.2	5.9	5.273	1010.27	86	0
2c	DFO-5	Full	2018-08-02	5:54	60° 28,105'	60° 38,106'	WBAT ↑	1424	279	1.7	5.9	5.205	1010.02	87	0
2c	DFO-5	Full	2018-08-02	6:14	60° 28,369'	60° 36,259'	IKMT ↓	1418.47	208	13.5	4.8	5.076	1009.81	90	0
2c	DFO-5	Full	2018-08-02	7:35	60° 30,124'	60° 43,784'	IKMT ↑	1361.9	194	12.4	4.8	5.159	1009.54	92	0
2c	DFO-5	Full	2018-08-02	8:27	60° 28,418'	60° 36,175'	Drop camera ↓	1424	197	13.1	4.4	4.696	1009.59	93	0
2c	DFO-5	Full	2018-08-02	8:51	60° 28,581'	60° 36,380'	Drop camera (bottom)Start	1424	193	14.3	4.4	4.697	1009.30	94	0

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2c	DFO-5	Full	2018-08-02	9:22	60° 28,563'	60° 36,341'	Drop camera (bottom)End	1424	197	13.7	4.6	4.726	1009.25	93	0
2c	DFO-5	Full	2018-08-02	9:44	60° 28,635'	60° 36,326'	Drop camera ↑	1424	205	14.3	5.1	4.635	1008.99	89	0
2c	DFO-5	Full	2018-08-02	10:17	60° 28,165'	60° 35,299'	Box Core ↓	1424	210	12.9	5.8	4.512	1009.18	87	0
2c	DFO-5	Full	2018-08-02	10:40	60° 28,103'	60° 35,093'	Box core (bottom)	1424	202	13.3	5.6	4.596	1009.23	87	0
2c	DFO-5	Full	2018-08-02	11:14	60° 27,934'	60° 34,691'	Box Core ↑	1424	199	11.4	5.8	4.509	1009.27	85	0
2c	Hibio-B 2018	Mooring	2018-08-02	13:55	60° 28,419'	60° 22,515'	Mooring ↓	1854.81	181	15.0	5.9	4.601	1008.88	85	0
2c	(DFO-7) Spon	Nutrient	2018-08-02	14:55	60° 28,282'	60° 22,623'	Drop camera ↓	1900	200	16.0	6.3	4.825	1008.78	84	0
2c	(DFO-7) Spon	Nutrient	2018-08-02	15:33	60° 28,071'	60° 22,502'	Drop camera (bottom)start	1900	195	14.9	6.5	4.617	1008.61	83	0
2c	(DFO-7) Spon	Nutrient	2018-08-02	16:08	60° 27,988'	60° 22,980'	Drop camera (bottom)end	1929.58	198	16.8	6.5	4.920	1008.21	84	0
2c	(DFO-7) Spon	Nutrient	2018-08-02	16:47	60° 27,936'	60° 23,776'	Drop camera ↑	1865	193	15.2	6.7	4.920	1008.20	82	0
2c	(DFO-7) Spon	Nutrient	2018-08-02	17:15	60° 28,015'	60° 22,801'	CTD Rosette ↓	1940.02	207	16.6	6.9	4.571	1008.15	79	0
2c	(DFO-7) Spon	Nutrient	2018-08-02	18:58	60° 27,945'	60° 23,551'	CTD Rosette ↑	1839.49	211	14.7	6.2	4.913	1008.58	88	0
2c	(DFO-7) Spon	Nutrient	2018-08-02	19:22	60° 28,135'	60° 23,511'	HydroBios ↓	1900.08	206	14.3	6.1	5.195	1008.48	87	0
2c	(DFO-7) Spon	Nutrient	2018-08-02	20:30	60° 28,144'	60° 24,512'	Hydrobios ↑	1850.57	199	13.1	6.0	4.627	1008.59	88	0
2c	(DFO-7) Spon	Nutrient	2018-08-02	20:52	60° 28,272'	60° 23,354'	WBAT ↓	1960	206	14.1	6.3	4.892	1008.55	85	0
2c	(DFO-7) Spon	Nutrient	2018-08-02	21:51	60° 28,790'	60° 24,434'	WBAT ↑	1960	191	13.3	5.5	4.606	1008.68	91	0
2c	(DFO-7) Spon	Nutrient	2018-08-02	22:12	60° 28,312'	60° 23,318'	IKMT ↓	1960	179	13.3	5.3	4.649	1008.77	91	0
2c	(DFO-7) Spon	Nutrient	2018-08-02	23:43	60° 32,600'	60° 26,408'	IKMT ↑	1960	182	11.4	5.1	5.137	1008.78	93	0
2c	(DFO-7) Spon	Nutrient	2018-08-03	0:34	60° 28,555'	60° 22,880'	Box Core ↓	1899	192	11.8	5.3	4.579	1009.04	94	0
2c	(DFO-7) Spon	Nutrient	2018-08-03	1:09	60° 28,554'	60° 22,507'	Box core (bottom)	1899	165	11.6	5.2	4.648	1009.09	96	0
2c	(DFO-7) Spon	Nutrient	2018-08-03	1:53	60° 28,563'	60° 22,507'	Box Core ↑	1878.66	179	11.8	5.1	4.603	1008.97	97	0
2c	DFO-8	Full	2018-08-03	5:17	60° 28,078'	59° 15,455'	Drop camera ↓	2443	209	15.4	6.2	6.433	1008.87	91	0
2c	DFO-8	Full	2018-08-03	6:00	60° 28,111'	59° 15,656'	Drop camera (bottom)start	2443	207	16.9	6.5	6.129	1009.06	86	0
2c	DFO-8	Full	2018-08-03	6:30	60° 28,117'	59° 15,792'	Drop camera (bottom)end	2443	197	15.8	6.6	6.291	1008.86	85	0
2c	DFO-8	Full	2018-08-03	7:08	60° 28,153'	59° 15,826'	Drop camera ↑	2413.52	201	16.9	6.4	6.205	1008.77	85	0
2c	DFO-8	Full	2018-08-03	7:31	60° 28,106'	59° 15,448'	CTD Rosette ↓	2415.08	210	18.1	6.5	6.208	1008.66	83	0
2c	DFO-8	Full	2018-08-03	9:34	60° 27,992'	59° 14,546'	CTD Rosette ↑	2416.4	194	19.8	6.7	6.165	1008.33	84	0
2c	DFO-8	Full	2018-08-03	10:00	60° 28,082'	59° 15,475'	HydroBios ↓	2415.08	191	19.2	6.8	6.139	1008.26	85	0
2c	DFO-8	Full	2018-08-03	11:02	60° 28,033'	59° 15,329'	Hydrobios ↑	2413.69	194	25.1	7.0	6.141	1007.60	83	0
2c	DFO-8	Full	2018-08-03	11:28	60° 28,026'	59° 15,509'	WBAT ↓	2440	194	21.3	7.1	6.059	1007.68	84	0
2c	DFO-8	Full	2018-08-03	12:37	60° 27,924'	59° 15,435'	WBAT ↑	2414.89	193	22.7	6.8	6.175	1007.10	86	0
2c	DFO-8	Full	2018-08-03	13:02	60° 27,898'	59° 15,912'	IKMT ↓	2440	193	24.0	6.7	6.183	1006.72	88	
2c	DFO-8	Full	2018-08-03	14:15	60° 26,914'	59° 21,848'	IKMT ↑	2440	187	21.5	6.2	6.324	1006.32	91	
2c	DFO-8	Full	2018-08-03	14:59	60° 28,021'	59° 15,258'	Box Core ↓	2440	194	20.6	6.5	6.214	1006.15	91	0
2c	DFO-8	Full	2018-08-03	15:51	60° 28,098'	59° 14,883'	Box core (bottom)	1247	198	20.6	6.6	6.231	1006.03	92	0
2c	DFO-8	Full	2018-08-03	16:33	60° 28,047'	59° 14,730'	Box Core ↑	2440	183	26.1	6.6	6.203	1005.54	92	0
2c	DFO-8	Full	2018-08-03	16:53	60° 28,049'	59° 14,648'	Box Core ↓	2445	192	23.4	6.6	5.764	1005.64	92	0
2c	DFO-8	Full	2018-08-03	17:37	60° 28,062'	59° 14,709'	Box core (bottom)	2445	187	26.3	6.3	5.702	1005.07	93	0
2c	DFO-8	Full	2018-08-03	18:21	60° 28,106'	59° 14,697'	Box Core ↑	2443	175	22.1	6.3	5.835	1005.18	93	0
2c	DFO-9	Full	2018-08-03	20:17	60° 28,117'	58° 48,738'	Drop camera ↓	2523	183	24.9	6.5	5.804	1005.14	95	0
2c	DFO-9	Full	2018-08-03	21:02	60° 28,058'	58° 48,819'	Drop camera (bottom)start	2523	181	20.0	6.6	6.342	1005.22	95	0
2c	DFO-9	Full	2018-08-03	21:33	60° 28,129'	58° 48,910'	Drop camera (bottom)end	2523	188	23.2	6.5	5.605	1005.08	96	0
2c	DFO-9	Full	2018-08-03	22:14	60° 28,166'	58° 48,772'	Drop camera ↑	2491.96	172	22.7	6.4	5.739	1004.20	97	0
2c	DFO-9	Full	2018-08-03	22:39	60° 28,261'	58° 48,791'	CTD Rosette ↓	2489.32	185	23.6	6.5	6.048	1004.22	96	0
2c	DFO-9	Full	2018-08-04	0:47	60° 28,684'	58° 48,731'	CTD Rosette ↑	2482.56	205	18.8	6.5	6.286	1004.31	96	0
2c	DFO-9	Full	2018-08-04	1:03	60° 28,144'	58° 48,860'	Net Phyto ↓	2492.33	223	18.1	6.6	6.324	1004.47	96	0
2c	DFO-9	Full	2018-08-04	1:08	60° 28,209'	58° 48,879'	Net Phyto ↑	2490.45	234	19.8	6.6	6.326	1004.47	96	0
2c	DFO-9	Full	2018-08-04	1:28	60° 28,393'	58° 49,234'	HydroBios ↓	2485.57	246	16.8	6.6	6.343	1004.62	95	0
2c	DFO-9	Full	2018-08-04	2:33	60° 28,681'	58° 49,273'	Hydrobios ↑		233	10.3	6.5	6.294	1003.88	94	0
2c	DFO-9	Full	2018-08-04	3:04	60° 28,052'	58° 48,685'	WBAT ↓	2525	255	11.0	6.4	6.391	1003.70	95	0
2c	DFO-9	Full	2018-08-04	4:10	60° 28,379'	58° 48,559'	WBAT ↑	2519	268	13.7	6.8	6.284	1003.97	96	0
2c	DFO-9	Full	2018-08-04	4:29	60° 28,328'	58° 47,920'	IKMT ↓	2519	278	11.0	7.1	6.274	1004.07	95	

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2c	DFO-9	Full	2018-08-04	5:50	60° 28,675'	58° 48,609'	IKMT ↑	2519	251	10.9	7.0	6.226	1004.41	96	0
2c	DFO-11	Full	2018-08-04	10:18	60° 26,476'	57° 05,401'	CTD Rosette ↓	3026	281	23.2	6.0	7.299	1006.19	84	0
2c	DFO-11	Full	2018-08-04	12:42	60° 27,195'	57° 04,901'	CTD Rosette ↑	3026	270	18.3	4.6	7.238	1007.67	92	
2c	DFO-11	Full	2018-08-04	13:05	60° 26,342'	57° 05,069'	Net Phyto ↓	3026	264	20.8	4.7	7.241	1007.81	94	0
2c	DFO-11	Full	2018-08-04	13:11	60° 26,339'	57° 05,069'	Net Phyto ↑	3026	270	23.0	4.8	7.174	1007.83	95	0
2c	DFO-11	Full	2018-08-04	13:24	60° 26,401'	57° 05,067'	HydroBios ↓	3026	276	22.8	4.8	7.233	1008.02	94	
2c	DFO-11	Full	2018-08-04	14:27	60° 26,462'	57° 04,716'	Hydrobios ↑	2938.45	278	24.4	4.9	7.221	1008.10	93	0
2c	DFO-11	Full	2018-08-04	14:57	60° 26,485'	57° 05,372'	WBAT ↓	3028	279	24.2	5.0	7.224	1008.53	92	
2c	DFO-11	Full	2018-08-04	16:16	60° 26,594'	57° 04,839'	WBAT ↑	3028	267	24.6	4.9	7.184	1009.17	92	0
2c	Hatton Bassin	ROV	2018-08-05	5:30	61° 26,236'	60° 40,039'	CTD Rosette ↓	612	242	12.0	4.8	4.716	1013.09	88	0
2c	Hatton Bassin	ROV	2018-08-05	6:19	61° 26,026'	60° 40,318'	CTD Rosette ↑	604	244	13.9	4.7	4.785	1013.24	89	0
2c	Hatton Bassin	ROV	2018-08-05	6:46	61° 26,422'	60° 39,903'	Monster Net ↓	612	241	11.8	4.5	4.532	1013.68	91	0
2c	Hatton Bassin	ROV	2018-08-05	7:21	61° 26,256'	60° 39,721'	Monster Net ↑	612	236	13.7	4.5	4.751	1013.26	90	0
2c	Hatton Bassin	ROV	2018-08-05	7:37	61° 26,168'	60° 39,616'	Net Phyto ↓	635	235	9.9	4.7	4.800	1013.38	89	0
2c	Hatton Bassin	ROV	2018-08-05	7:42	61° 26,155'	60° 39,536'	Net Phyto ↑	1328.87	232	9.5	4.8	4.818	1013.39	89	0
2c	Hatton Bassin	ROV	2018-08-05	8:00	61° 26,436'	60° 39,769'	CTD Rosette ↓	621	232	8.8	5.1	4.735	1013.51	87	0
2c	Hatton Bassin	ROV	2018-08-05	8:20	61° 26,253'	60° 39,397'	CTD Rosette ↑	1285.94	225	7.2	5.3	4.734	1013.55	85	0
2c	Hatton Bassin	ROV	2018-08-05	9:35	61° 26,367'	60° 39,786'	ROV ↓	625	133	5.5	5.3	4.758	1013.31	81	0
2c	Hatton Bassin	ROV	2018-08-05	10:12	61° 26,374'	60° 39,805'	ROV (bottom)Start	625	133	7.8	5.6	4.628	1013.39	78	0
2c	Hatton Bassin	ROV	2018-08-05	14:32	61° 26,796'	60° 42,607'	ROV (bottom)END	625	156	10.5	6.0	4.528	1012.32	91	0
2c	Hatton Bassin	ROV	2018-08-05	15:11	61° 26,705'	60° 42,742'	ROV ↑	625	172	11.8	5.9	4.494	1012.11	93	0
2c	Lophelia	ROV	2018-08-06	22:24	60° 22,180'	48° 27,748'	CTD Rosette ↓	700	152	7.6	3.9	5.368	1018.79	100	0
2c	Lophelia	ROV	2018-08-06	22:43	60° 22,352'	48° 28,187'	CTD Rosette ↑	631.16	127	8.2	3.7	5.114	1017.90	100	0
2c	Lophelia	ROV	2018-08-07	0:17	60° 21,980'	48° 27,437'	CTD Rosette ↓	882.85	158	9.9	4.9	5.167	1018.69	100	0
2c	Lophelia	ROV	2018-08-07	1:11	60° 22,586'	48° 28,210'	CTD Rosette ↑	569.45	123	11.8	5.2	5.386	1018.41	100	0
2c	Lophelia	ROV	2018-08-07	1:37	60° 22,217'	48° 27,408'	Net Phyto ↓	675.68	132	11.6	5.1	5.795	1018.24	100	0
2c	Lophelia	ROV	2018-08-07	1:39	60° 22,240'	48° 27,398'	Net Phyto ↑	673.48	131	10.9	5.2	5.799	1018.26	100	0
2c	Lophelia	ROV	2018-08-07	2:05	60° 22,045'	48° 27,493'	Net Phyto ↓	791.87	126	13.3	5.3	5.853	1018.14	100	0
2c	Lophelia	ROV	2018-08-07	2:10	60° 22,095'	48° 27,502'	Net Phyto ↑	738.49	123	13.7	5.2	5.856	1018.13	100	0
2c	Lophelia	ROV	2018-08-07	3:22	60° 24,864'	48° 27,290'	Surf Microplastics Trawling ↓	396.51	119	12.8	5.0	4.811	1017.05	100	0
2c	Lophelia	ROV	2018-08-07	4:01	60° 23,347'	48° 27,192'	Surf Microplastics Trawling ↓	680.27	120	13	5.2	4.851	1019.45	100	0
2c	Lophelia	ROV	2018-08-07	4:32	60° 22,010'	48° 27,301'	Surf Microplastics Trawling ↑	919.32	125	13.9	5.7	5.405	1016.92	100	0
2c	Lophelia	ROV	2018-08-07	4:40	60° 21,784'	48° 27,374'	Surf Microplastics Trawling ↓	1200.13	121	12.0	5.7	5.644	1017.09	100	0
2c	Lophelia	ROV	2018-08-07	5:10	60° 20,404'	48° 27,382'	Surf Microplastics Trawling ↑	1945	141	16.0	6.6	6.277	1018.01	100	0
2c	Lophelia	ROV	2018-08-07	5:17	60° 20,222'	48° 27,513'	Surf Microplastics Trawling ↓	2085	129	13.7	6.6	6.253	1018.07	100	0
2c	Lophelia	ROV	2018-08-07	5:48	60° 18,848'	48° 27,674'	Surf Microplastics Trawling ↑	3311	129	15.8	6.8	6.187	1017.93	100	0
2c	Lophelia	ROV	2018-08-07	6:23	60° 22,159'	48° 27,433'	CTD Rosette ↓	699.27	109	14.1	6.3	5.904	1017.05	100	0
2c	Lophelia	ROV	2018-08-07	7:11	60° 22,729'	48° 28,283'	CTD Rosette ↑	587.29	110	13.7	5.8	5.854	1016.01	100	0
2c	Lophelia	ROV	2018-08-07	7:33	60° 22,116'	48° 27,447'	Monster Net ↓	656.12	112	12.8	6.2	6.212	1016.08	100	0
2c	Lophelia	ROV	2018-08-07	8:11	60° 22,349'	48° 28,679'	Monster Net ↑	625.95	102	12.8	5.7	6.206	1015.66	100	0
2c	Lophelia	ROV	2018-08-07	8:41	60° 22,216'	48° 28,234'	Drop camera ↓	685	112	14.7	5.7	6.188	1015.49	100	0
2c	Lophelia	ROV	2018-08-07	8:53	60° 22,369'	48° 28,520'	Drop camera (bottom)Start	635	106	14.9	5.6	6.229	1015.54	100	0
2c	Lophelia	ROV	2018-08-07	9:25	60° 22,358'	48° 29,120'	Drop camera (bottom)End	685	116	15.0	5.8	6.332	1015.71	100	0
2c	Lophelia	ROV	2018-08-07	9:34	60° 22,411'	48° 29,323'	Drop camera ↑	615.46	107	15.0	5.9	6.217	1015.86	100	0
2c	Lophelia	ROV	2018-08-07	10:30	60° 21,974'	48° 27,403'	ROV ↓	870	115	18.5	5.9	6.207	1015.89	100	0
2c	Lophelia	ROV	2018-08-07	12:13	60° 21,969'	48° 27,431'	ROV (bottom)Start	870	111	18.1	5.8	6.234	1013.86	100	0
2c	Lophelia	ROV	2018-08-07	16:32	00° 00,000'	00° 00,000'	ROV (bottom)End								
2c	Lophelia	ROV	2018-08-07	17:11	60° 22,299'	48° 28,350'	ROV ↑	646	103	14.1	6.5	6.038	1011.29	101	0
2c	Lophelia	ROV	2018-08-08	10:31	60° 22,013'	48° 27,974'	ROV ↓	761	105	10.5	6.1	6.633	1008.38	101	0
2c	Lophelia	ROV	2018-08-08	11:30	60° 21,987'	48° 27,956'	ROV (bottom)Start	793	103	10.3	6.3	6.632	1008.06	101	0
2c	Lophelia	ROV	2018-08-08	15:57	60° 21,938'	48° 28,129'	ROV (bottom)End	761	58	6.9	5.5	6.658	1006.54	101	0
2c	Lophelia	ROV	2018-08-08	16:39	60° 22,208'	00° 00,000'	ROV ↑	761	60	7.6	5.2	6.731	1006.17	101	0

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2c	NLSE07	Nutrient	2018-08-09	14:51	63° 14,977'	54° 12,028'	Net Phyto ↓	1176.39	359	13.1	5.0	6.556	1005.84	101	0
2c	NLSE07	Nutrient	2018-08-09	14:56	63° 14,991'	54° 12,012'	Net Phyto ↑	1176.39	358	14.9	4.9	6.324	1005.74	100	0
2c	NLSE07	Nutrient	2018-08-09	15:09	63° 15,054'	54° 11,934'	CTD Rosette ↓	1175.29	347	13.1	4.9	6.588	1005.86	101	0
2c	NLSE07	Nutrient	2018-08-09	16:37	63° 14,968'	54° 11,831'	CTD Rosette ↑	1177.21	348	16.0	5.0	6.691	1005.23	100	0
2c	SW Greenlan	Nutrient	2018-08-09	21:28	63° 59,968'	55° 30,040'	Net Phyto ↓	1078.98	329	7.0	6.1	4.561	1005.15	99	0
2c	SW Greenlan	Nutrient	2018-08-09	21:32	63° 59,947'	55° 30,088'	Net Phyto ↑	1078.73	331	6.9	6.1	4.494	1005.09	99	0
2c	SW Greenlan	Nutrient	2018-08-09	21:43	63° 59,882'	55° 30,188'	CTD Rosette ↓	1078.23	325	6.9	6.0	4.723	1005.08	99	0
2c	SW Greenlan	Nutrient	2018-08-09	22:52	63° 59,777'	55° 30,886'	CTD Rosette ↑	1073.27	350	6.9	6.3	5.619	1004.88	97	0
2c	SW Greenlan	Nutrient	2018-08-10	11:28	66° 29,909'	57° 00,105'	Net Phyto ↓	665.37	296	0.6	5.4	0.390	1002.59	78	0
2c	SW Greenlan	Nutrient	2018-08-10	11:33	66° 29,904'	57° 00,224'	Net Phyto ↑	666.02	166	8.8	5.0	0.326	1002.57	82	0
2c	SW Greenlan	Nutrient	2018-08-10	11:43	66° 29,936'	57° 00,509'	CTD Rosette ↓	667.45	167	6.5	6.4	0.443	1002.49	74	0
2c	SW Greenlan	Nutrient	2018-08-10	12:37	66° 29,971'	57° 01,847'	CTD Rosette ↑	671.47	178	8.6	4.6	0.384	1002.56	84	0
2c	Disko Fan	Basic	2018-08-10	21:58	67° 58,602'	59° 30,441'	Net Phyto ↓	901.13	147	24.4	2.5	-0.823	997.56	91	2
2c	Disko Fan	Basic	2018-08-10	22:02	67° 58,638'	59° 30,503'	Net Phyto ↑	902.38	140	24.9	2.5	-0.828	997.52	92	2
2c	Disko Fan	Basic	2018-08-10	22:15	67° 58,720'	59° 30,752'	CTD Rosette ↓	910.6	146	21.1	2.6	-0.821	997.49	93	2
2c	Disko Fan	Basic	2018-08-10	23:17	67° 59,536'	59° 31,521'	CTD Rosette ↑	898.63	145	24.0	2.1	-0.964	997.11	94	2
2c	Disko Fan	Basic	2018-08-10	23:56	67° 58,043'	59° 29,692'	Gravity Core ↓	895.42	149	23.4	2.1	-0.873	996.84	95	2
2c	Disko Fan	Basic	2018-08-11	0:09	67° 58,280'	59° 29,725'	Gravity Core BOT	884.59	152	23.8	2.2	-0.867	997.03	95	2
2c	Disko Fan	Basic	2018-08-11	0:25	67° 58,536'	59° 29,933'	Gravity Core ↑	879.84	155	22.5	2.3	-0.960	996.82	96	2
2c	Disko Fan	Basic	2018-08-11	0:47	67° 58,010'	59° 29,356'	Gravity Core ↓	880.9	150	25.7	2.2	-0.831	996.89	96	2
2c	Disko Fan	Basic	2018-08-11	1:03	67° 58,212'	59° 29,522'	Gravity Core BOT	880.14	158	23.2	1.8	-0.852	996.91	97	2
2c	Disko Fan	Basic	2018-08-11	1:18	67° 58,468'	59° 29,783'	Gravity Core ↑	877.91	150	21.7	1.9	-0.902	996.83	98	2
2c	Disko Fan	Basic	2018-08-11	1:38	67° 58,110'	59° 29,920'	Gravity Core ↓	905.51	150	24.6	1.8	-0.761	996.52	99	2
2c	Disko Fan	Basic	2018-08-11	1:55	67° 58,367'	59° 30,023'	Gravity Core BOT	892.95	159	23.6	1.6	-0.861	996.96	99	2
2c	Disko Fan	Basic	2018-08-11	2:10	67° 58,540'	59° 30,314'	Gravity Core ↑	899.41	147	21.9	1.4	-0.822	996.90	99	2
2c	Disko Fan	Basic	2018-08-11	2:27	67° 58,013'	59° 29,429'	Gravity Core ↓	885.33	156	25.1	1.4	-0.787	996.59	99	2
2c	Disko Fan	Basic	2018-08-11	2:44	67° 58,240'	59° 29,473'	Gravity Core BOT	875.33	160	22.3	1.1	-0.834	996.71	99	2
2c	Disko Fan	Basic	2018-08-11	2:59	67° 58,407'	59° 29,612'	Gravity Core ↑	869.54	158	23.8	1.1	-0.800	996.50	100	2
2c	Disko Fan	Basic	2018-08-11	3:14	67° 58,013'	59° 29,569'	Gravity Core ↓	892.18	159	24.2	0.8	-0.801	996.63	100	2
2c	Disko Fan	Basic	2018-08-11	3:30	67° 58,174'	59° 29,362'	Gravity Core BOT	873.85	156	20.6	0.8	-0.784	996.71	99	2
2c	Disko Fan	Basic	2018-08-11	3:45	67° 58,281'	59° 29,451'	Gravity Core ↑	871.61	158	22.8	0.7	-0.807	996.27	100	0
2c	Disko Fan	Basic	2018-08-11	4:07	67° 58,026'	59° 29,461'	Box Core ↓	882	163	21.3	0.6	-0.779	996.80	100	1
2c	Disko Fan	Basic	2018-08-11	4:27	67° 58,213'	59° 29,506'	Box core (bottom)	882	153	21.7	0.6	-0.783	996.68	100	1
2c	Disko Fan	Basic	2018-08-11	4:44	67° 58,378'	59° 29,585'	Box Core ↑	872.95	143	22.3	0.6	-0.762	996.30	100	1
2c	Disko Fan	Basic	2018-08-11	5:07	67° 58,348'	59° 30,183'	Argo Float ↓	905.65	153	15.2	0.5	-0.843	996.66	100	1
2c	SW Greenlan	Nutrient	2018-08-11	13:59	68° 58,569'	62° 28,971'	Net Phyto ↓	1892	287	8.8	1.5	-0.809	998.61	100	5
2c	SW Greenlan	Nutrient	2018-08-11	14:06	68° 58,588'	62° 28,988'	Net Phyto ↑	1892	291	8.9	1.6	-0.873	998.60	100	5
2c	SW Greenlan	Nutrient	2018-08-11	14:14	68° 58,649'	62° 28,984'	CTD Rosette ↓	1892	292	8.6	1.4	-0.905	998.67	100	5
2c	SW Greenlan	Nutrient	2018-08-11	15:56	68° 59,191'	62° 29,172'	CTD Rosette ↑	1896	1	3.4	1.2	-0.815	999.76	100	5
2c	Scott Inlet	ROV	2018-08-12	12:16	71° 22,581'	70° 04,611'	CTD Rosette ↓	259.95	115	9.5	2.6	2.019	1001.90	100	0
2c	Scott Inlet	ROV	2018-08-12	13:01	71° 22,218'	70° 04,714'	CTD Rosette ↑	221.8	124	8.2	2.8	2.478	1001.79	101	0
2c	Scott Inlet	ROV	2018-08-12	13:31	71° 22,676'	70° 04,481'	ROV ↓	262	122	6.7	3.0	2.508	1001.96	101	0
2c	Scott Inlet	ROV	2018-08-12	14:08	71° 22,687'	70° 04,471'	ROV (bottom)Start	262	126	7.8	2.7	2.546	1001.83	100	0
2c	Scott Inlet	ROV	2018-08-12	15:31	71° 22,778'	70° 04,285'	ROV (bottom)End	262	122	10.1	2.5	2.528	1001.50	101	0
2c	Scott Inlet	ROV	2018-08-12	15:53	71° 22,759'	70° 04,473'	ROV ↑	256	115	8.4	2.3	2.531	1001.57	101	0
2c	Scott Inlet	ROV	2018-08-12	16:36	71° 23,192'	70° 03,128'	CTD Rosette ↓	254	118	10.1	2.3	2.176	1001.56	100	0
2c	Scott Inlet	ROV	2018-08-12	17:01	71° 23,182'	70° 03,027'	CTD Rosette ↑	258.59	110	8	2.5	2.429	1003.95	101	0
2c	Scott Inlet	ROV	2018-08-12	17:57	71° 23,124'	70° 03,162'	ROV ↓	257.7	71	5.9	2.6	2.316	1001.39	101	0
2c	Scott Inlet	ROV	2018-08-12	18:19	71° 23,131'	70° 03,165'	ROV (bottom)Start	257.33	95	6.5	2.2	2.668	1001.44	101	0
2c	Scott Inlet	ROV	2018-08-12	20:13	71° 22,738'	70° 04,309'	ROV (bottom)End	264.6	83	8.4	1.1	2.649	1001.27	101	0
2c	Scott Inlet	ROV	2018-08-12	20:31	71° 22,703'	70° 04,388'	ROV ↑	266.79	59	6.1	2.4	2.678	1001.28	101	0
2c	0 time1 A1	CTD	2018-08-12	22:35	71° 22,626'	70° 04,353'	CTD Rosette ↓	262	66	7.8	1.5	2.667	1001.08	101	0

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2c	0 time1 A1	CTD	2018-08-12	22:54	71° 22,557'	70° 04,308'	CTD Rosette ↑	262	191	0.8	1.6	2.810	1001.07	101	0
2c	SW-5K E	CTD	2018-08-12	23:31	71° 20,835'	70° 10,335'	CTD Rosette ↓	226	73	8.8	1.8	2.736	1001.09	101	0
2c	SW-5K E	CTD	2018-08-12	23:48	71° 20,853'	70° 10,544'	CTD Rosette ↑	226	60	8.2	1.7	2.881	1001.02	101	0
2c	(SW-1K) D	CTD	2018-08-13	0:30	71° 22,335'	70° 05,564'	CTD Rosette ↓	251	76	6.5	1.8	2.662	1001.17	101	0
2c	(SW-1K) D	CTD	2018-08-13	0:48	71° 22,361'	70° 05,787'	CTD Rosette ↑	252	74	8.2	2.0	2.688	1001.08	101	0
2c	(SW-1K) D	Other	2018-08-13	1:34	71° 22,320'	70° 05,430'	Agassiz Trawl ↓	245.83	62	6.5	1.7	2.558	1001.03	101	0
2c	(SW-1K) D	Other	2018-08-13	1:55	71° 22,412'	70° 04,036'	Agassiz Trawl ↑	238.54	52	7.8	1.8	2.664	1000.94	101	0
2c	(0 time 2) A2	CTD	2018-08-13	2:34	71° 22,778'	70° 04,170'	CTD Rosette ↓	265.1	49	5.0	1.8	2.709	1000.85	101	0
2c	(0 time 2) A2	CTD	2018-08-13	3:05	71° 22,708'	70° 04,122'	CTD Rosette ↑	265	50	3.4	1.9	2.143	1000.95	101	0
2c	Nw-5k-g	CTD	2018-08-13	3:51	71° 24,513'	70° 10,664'	CTD Rosette ↓	557.34	33	3.6	1.9	2.233	1001.03	101	0
2c	Nw-5k-g	CTD	2018-08-13	4:18	71° 24,578'	70° 10,819'	CTD Rosette ↑	557	38	2.9	2.1	2.452	1001.08	101	0
2c	Nw-5k-g	Other	2018-08-13	4:31	71° 24,508'	70° 10,639'	Net Phyto ↓	547.14	56	1.5	2.5	2.293	1000.99	101	0
2c	Nw-5k-g	Other	2018-08-13	4:36	71° 24,507'	70° 10,657'	Net Phyto ↑	560.91	24	1.5	2.5	2.634	1000.99	101	0
2c	Nw-1k-f	CTD	2018-08-13	5:31	71° 23,079'	70° 05,466'	CTD Rosette ↓	311.54	339	3.8	2.2	2.343	1001.04	101	0
2c	Nw-1k-f	CTD	2018-08-13	5:50	71° 23,087'	70° 05,381'	CTD Rosette ↑	311.5	344	5.0	2.2	2.555	1000.96	101	0
2c	(0 time 3) A3	CTD	2018-08-13	6:27	71° 22,725'	70° 04,286'	CTD Rosette ↓	264.43	340	5.9	2.2	2.741	1001.00	101	0
2c	(0 time 3) A3	CTD	2018-08-13	6:45	71° 22,706'	70° 04,133'	CTD Rosette ↑	263	349	4.8	2.1	2.708	1001.09	101	0
2c	SE-5K I	CTD	2018-08-13	7:28	71° 21,002'	69° 57,811'	CTD Rosette ↓	216.62	24	1.0	2.3	2.644	1001.20	101	0
2c	SE-5K I	CTD	2018-08-13	7:43	71° 20,992'	69° 57,585'	CTD Rosette ↑	215	14	5.5	2.0	2.657	1001.18	101	0
2c	SE-1K H	CTD	2018-08-13	9:34	71° 22,369'	70° 02,886'	CTD Rosette ↓	215.48	96	1.5	1.4	2.700	1001.36	101	0
2c	SE-1K H	CTD	2018-08-13	9:48	71° 22,289'	70° 02,862'	CTD Rosette ↑	211	29	7.2	1.2	2.684	1001.32	101	0
2c	NE-5K C	ROV	2018-08-13	10:42	71° 24,569'	69° 58,292'	ROV ↓	268.52	359	7.4	1.5	2.165	1001.29	101	0
2c	NE-5K C	ROV	2018-08-13	11:05	71° 24,575'	69° 58,300'	ROV (bottom)Start	266	351	6.5	1.5	2.139	1001.43	101	0
2c	NE-5K C	ROV	2018-08-13	12:03	71° 24,581'	69° 58,300'	ROV (bottom)End	266	317	6.5	1.7	2.191	1001.62	101	0
2c	NE-5K C	ROV	2018-08-13	12:17	71° 24,582'	00° 00,000'	ROV ↑	266	323	6.5	2.1	2.195	1001.70	101	0
2c	NE-5K C	CTD	2018-08-13	12:39	71° 24,574'	69° 58,386'	CTD Rosette ↓	266	327	7.6	2.0	2.295	1001.71	101	0
2c	NE-5K C	CTD	2018-08-13	12:55	71° 24,555'	69° 58,435'	CTD Rosette ↑	266	325	8.8	1.9	2.506	1001.57	101	0
2c	0 time4 A4	CTD	2018-08-13	13:31	71° 22,707'	70° 04,484'	CTD Rosette ↓	265	320	8.8	1.9	2.366	1001.63	101	0
2c	0 time4 A4	CTD	2018-08-13	13:58	71° 22,618'	70° 04,617'	CTD Rosette ↑	266	316	9.7	2.0	2.430	1001.56	101	0
Leg 3															
3	River in Lefeu	River	2018-08-18	13:49	72° 22,597'	95° 55,843'	Helicopter ↓	399.23	210	25.1	1.3	0.111	991.95	90	0
3	River in Lefeu	River	2018-08-18	16:02	72° 03,116'	96° 01,081'	Helicopter ↑	420.24	216	21.5	0.6	-0.924	992.96	92	0
3	312	Basic	2018-08-19	12:03	69° 10,290'	100° 41,716'	Secchi Disk ↓	1076.77	181	6.1	3.2	1.202	1000.21	93	0
3	312	Basic	2018-08-19	12:05	69° 10,323'	100° 41,621'	Secchi Disk ↑	996.13	246	9.9	4.9	1.228	1000.20	85	0
3	312	Basic	2018-08-19	12:49	69° 10,475'	100° 41,789'	CTD Rosette ↓	67.89	262	18.5	4.9	1.368	1000.01	81	0
3	312	Basic	2018-08-19	13:13	69° 10,920'	100° 40,856'	CTD Rosette ↑	64.19	261	13.5	1.8	1.324	1000.23	97	0
3	312	Basic	2018-08-19	13:47	69° 10,393'	100° 40,623'	Tucker Net ↓	58.78	284	15.2	2.1	1.654	1000.29	91	0
3	312	Basic	2018-08-19	14:03	69° 10,912'	100° 38,939'	Tucker Net ↑	58.53	286	24.4	2.6	1.732	999.96	91	0
3	312	Basic	2018-08-19	14:38	69° 10,603'	100° 41,042'	Monster Net ↓	63.24	280	19.6	1.7	1.773	999.89	97	0
3	312	Basic	2018-08-19	14:44	69° 10,670'	100° 40,783'	Monster Net ↑	63.54	304	10.9	5.8	1.554	1000.41	75	0
3	312	Basic	2018-08-19	15:08	69° 10,386'	100° 42,036'	CTD Rosette ↓	68.98	287	21.1	1.6	1.277	1000.10	95	0
3	312	Basic	2018-08-19	15:38	69° 10,928'	100° 40,133'	CTD Rosette ↑	58.11	284	17.7	1.7	1.621	1000.20	95	0
3	312	Basic	2018-08-19	16:12	69° 10,209'	100° 41,977'	Box Core ↓	67.46	268	19.2	1.9	1.258	1000.08	94	0
3	312	Basic	2018-08-19	16:12	69° 10,209'	100° 41,977'	Box core (bottom)	67.46	268	19.2	1.9	1.258	1000.08	94	0
3	312	Basic	2018-08-19	16:15	69° 10,190'	100° 41,912'	Box Core ↑	66.2	258	18.7	1.9	1.295	1000.20	94	0
3	312	Basic	2018-08-19	16:35	69° 10,339'	100° 41,788'	Agassiz Trawl ↓	67.89	285	20.0	1.7	1.182	1000.45	95	0
3	312	Basic	2018-08-19	16:46	69° 10,705'	100° 41,607'	Agassiz Trawl ↑	66.18	277	18.5	1.8	1.162	1000.47	91	0
3	QMG1	Basic	2018-08-21	4:48	68° 29,404'	99° 53,138'	Rosette ↓	37.04	334	11.8	1.6	2.488	1003.55	96	0
3	QMG1	Basic	2018-08-21	5:06	68° 29,388'	99° 53,013'	Rosette ↑	36.9	345	2.5	2.4	3.360	1003.54	94	0
3	QMG1	Basic	2018-08-21	5:19	68° 29,447'	99° 53,101'	Tucker Net ↓	34.94	334	13.7	1.4	3.503	1003.45	96	0
3	QMG1	Basic	2018-08-21	5:32	68° 29,193'	99° 53,518'	Tucker Net ↑	39.94	329	9.1	1.6	3.760	1003.61	94	0
3	QMG1	Basic	2018-08-21	5:56	68° 29,301'	99° 53,402'	Monster Net ↓	36.61	324	10.7	1.3	3.100	1003.69	94	0

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3	QMG1	Basic	2018-08-21	5:59	68° 29,316'	99° 53,368'	Monster Net ↑	36.44	324	12.6	1.8	2.537	1003.61	93	0
3	QMG1	Basic	2018-08-21	6:30	68° 29,406'	99° 53,244'	Box Core ↓	39.43	317	9.5	1.3	3.261	1003.61	95	0
3	QMG1	Basic	2018-08-21	6:32	68° 29,407'	99° 53,244'	Box Core On Bot	39.29	316	10.1	1.2	3.135	1003.61	95	0
3	QMG1	Basic	2018-08-21	6:34	68° 29,409'	99° 53,247'	Box Core ↑	39.3	314	10.9	1.3	2.794	1003.58	95	0
3	QMG1	Basic	2018-08-21	6:50	68° 29,476'	00° 00,000'	Agassiz Trawl ↓	33.64	325	10.7	1.5	2.980	1003.61	96	0
3	QMG1	Basic	2018-08-21	7:06	68° 29,055'	99° 53,672'	Agassiz Trawl ↑	48.57	290	1.3	2.0	3.773	1003.57	96	0
3	QMG1	Basic	2018-08-21	7:42	68° 28,693'	99° 52,896'	Beam Trawl ↓	40.73	315	9.1	1.7	3.786	1003.51	95	0
3	QMG1	Basic	2018-08-21	7:52	68° 28,975'	99° 52,272'	Beam Trawl ↑	38.74	315	8.9	1.7	3.784	1003.49	97	0
3	QMG1	Basic	2018-08-21	7:52	68° 28,975'	99° 52,272'	Beam Trawl ↑	38.74	315	8.9	1.7	3.784	1003.49	97	0
3	QMG2	Basic	2018-08-21	10:05	68° 18,593'	100° 47,859'	CTD Rosette ↓	64.53	258	0.8	2.9	2.993	1003.50	99	0
3	QMG2	Basic	2018-08-21	10:28	68° 18,620'	100° 47,931'	CTD Rosette ↑	63.82	291	3.4	3.3	3.289	1003.52	98	0
3	QMG2	Basic	2018-08-21	10:38	68° 18,613'	100° 47,666'	Tucker Net ↓	64.67	280	7.8	2.6	3.541	1003.47	98	0
3	QMG2	Basic	2018-08-21	10:46	68° 18,794'	100° 47,208'	Tucker Net ↑	59.77	291	8.9	2.5	3.639	1003.53	99	0
3	QMG2	Basic	2018-08-21	11:07	68° 18,589'	100° 48,051'	Monster Net ↓	76.9	311	12.6	2.5	3.033	1003.51	94	0
3	QMG2	Basic	2018-08-21	11:14	68° 18,582'	100° 48,063'	Monster Net ↑	76.38	289	12.9	2.5	3.024	1003.37	95	0
3	QMG2	Basic	2018-08-21	11:36	68° 18,593'	100° 48,009'	Box Core ↓	73.46	307	10.7	3.4	3.106	1003.54	93	0
3	QMG2	Basic	2018-08-21	11:38	68° 18,592'	100° 47,996'	Box core (bottom)	73.07	319	8.0	4.9	3.116	1003.54	83	0
3	QMG2	Basic	2018-08-21	11:40	68° 18,587'	100° 47,982'	Box Core ↑	71.74	332	7.4	4.2	3.190	1003.53	86	0
3	QMG2	Basic	2018-08-21	11:57	68° 18,560'	100° 47,902'	Agassiz Trawl ↓	66.2	306	11.8	2.1	2.947	1003.33	95	0
3	QMG2	Basic	2018-08-21	12:05	68° 18,590'	100° 47,427'	Agassiz Trawl ↑	69.01	305	10.1	2.3	3.508	1003.40	94	0
3	QMG4	Basic	2018-08-22	4:09	68° 28,755'	103° 26,071'	Rosette ↓	68.09	55	10.9	1.0	2.493	1003.68	99	0
3	QMG4	Basic	2018-08-22	4:37	68° 28,618'	103° 25,688'	Rosette ↑	68.66	57	8.6	0.5	2.612	1003.66	99	0
3	QMG4	Basic	2018-08-22	4:44	68° 28,600'	103° 25,592'	Tucker Net ↓	66.32	50	8.4	0.6	2.697	1003.72	99	0
3	QMG4	Basic	2018-08-22	4:54	68° 28,277'	103° 25,590'	Tucker Net ↑	68.27	76	5.9	0.7	2.798	1003.75	99	0
3	QMG4	Basic	2018-08-22	5:13	68° 28,866'	103° 25,323'	Monster Net ↓	71.35	58	8.0	0.5	2.813	1003.75	99	0
3	QMG4	Basic	2018-08-22	5:19	68° 28,834'	103° 25,235'	Monster Net ↑	70.44	70	6.3	1.3	2.804	1003.82	99	0
3	QMG4	Basic	2018-08-22	5:46	68° 28,838'	103° 25,598'	Box Core ↓	69.71	38	9.5	0.7	2.721	1003.78	99	0
3	QMG4	Basic	2018-08-22	5:48	68° 28,843'	103° 25,579'	Box core (bottom)	69.6	51	9.3	0.6	2.771	1003.75	99	0
3	QMG4	Basic	2018-08-22	5:50	68° 28,841'	103° 25,555'	Box Core ↑	69.74	50	10.7	0.5	2.770	1003.78	99	0
3	QMG4	Basic	2018-08-22	6:09	68° 28,718'	103° 25,999'	Agassiz Trawl ↓	67.51	53	8.0	1.2	2.872	1003.93	93	0
3	QMG4	Basic	2018-08-22	6:23	68° 28,561'	103° 25,630'	Agassiz Trawl ↑	66.54	51	14.9	0.9	2.917	1003.68	96	0
3	QMG4	Basic	2018-08-22	6:38	68° 28,844'	103° 25,722'	Beam Trawl ↓	66.75	41	10.3	0.9	2.921	1003.87	93	0
3	QMG4	Basic	2018-08-22	6:53	68° 28,660'	103° 24,891'	Beam Trawl ↑	67.91	45	13.7	1.0	2.854	1003.70	93	0
3	QMG3	Basic	2018-08-22	8:26	68° 19,642'	102° 56,092'	CTD Rosette ↓	54.5	17	12.4	0.9	2.523	1003.88	86	0
3	QMG3	Basic	2018-08-22	8:47	68° 19,518'	102° 56,146'	CTD Rosette ↑	53.02	354	12.9	0.9	2.517	1003.77	86	0
3	QMG3	Basic	2018-08-22	8:57	68° 19,450'	102° 56,274'	Tucker Net ↓	53.96	3	9.9	2.0	2.518	1003.81	82	0
3	QMG3	Basic	2018-08-22	9:05	68° 19,229'	102° 55,924'	Tucker Net ↑	44.65	357	9.7	1.1	2.494	1003.79	86	0
3	QMG3	Basic	2018-08-22	9:25	68° 19,830'	102° 56,451'	Monster Net ↓	50.82	350	11.8	0.8	2.534	1003.91	86	0
3	QMG3	Basic	2018-08-22	9:30	68° 19,814'	102° 56,460'	Monster Net ↑	50.78	353	10.7	0.9	2.539	1003.90	87	0
3	QMG3	Basic	2018-08-22	9:50	68° 19,787'	102° 56,497'	Box Core ↓	50.6	353	12.8	0.9	2.540	1003.86	86	0
3	QMG3	Basic	2018-08-22	9:52	68° 19,792'	102° 56,498'	Box core (bottom)	50.64	353	10.3	1.4	2.551	1003.87	87	0
3	QMG3	Basic	2018-08-22	9:53	68° 19,793'	102° 56,500'	Box Core ↑	50.67	349	12.2	1.5	2.552	1003.76	86	0
3	QMG3	Basic	2018-08-22	10:08	68° 19,783'	102° 56,497'	Agassiz Trawl ↓	50.61	346	11.0	1.7	2.571	1004.02	82	0
3	QMG3	Basic	2018-08-22	10:17	68° 19,576'	102° 56,209'	Agassiz Trawl ↑	54.09	347	12.6	1.0	2.509	1003.84	85	0
3	QMG3	Basic	2018-08-22	10:37	68° 19,772'	102° 56,232'	Beam Trawl ↓	50.97	358	17.1	1.1	2.528	1003.99	86	0
3	QMG3	Basic	2018-08-22	10:49	68° 19,400'	102° 55,392'	Beam Trawl ↑	49.98	345	14.1	0.8	2.481	1003.84	94	0
3	wf1	Mooring	2018-08-22	13:46	68° 14,497'	101° 47,868'	Zodiac ↑	98.76	340	16.6	1.0	3.831	1003.12	86	0
3	wf1	Mooring	2018-08-22	13:59	68° 14,301'	101° 48,060'	Mooring ↑	91.12	342	13.5	1.0	3.559	1003.35	86	0
3	QMGM	Basic	2018-08-22	14:36	68° 17,965'	101° 44,595'	Secchi Disk ↓	115.69	332	15.2	1.5	3.615	1003.23	88	0
3	QMGM	Basic	2018-08-22	14:40	68° 17,962'	101° 44,601'	Secchi Disk ↑		2	9.5	1.8	3.433	1003.29	86	0
3	QMGM	Basic	2018-08-22	14:43	68° 17,953'	101° 44,574'	CTD Rosette ↓	114.68	94	4.0	1.3	3.549	1003.32	88	0
3	QMGM	Basic	2018-08-22	15:17	68° 17,911'	101° 44,023'	CTD Rosette ↑	115.38	107	1.5	0.7	3.703	1003.46	97	0

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3	QMGM	Basic	2018-08-22	15:27	68° 17,711'	101° 43,515'	Tucker Net ↓	111.96	315	11.2	0.3	3.603	1003.45	98	0
3	QMGM	Basic	2018-08-22	15:44	68° 17,340'	101° 42,031'	Tucker Net ↑	112.91	310	10.9	0.3	3.550	1003.36	99	0
3	QMGM	Basic	2018-08-22	16:01	68° 17,993'	101° 44,380'	Monster Net ↓	115				3.674			0
3	QMGM	Basic	2018-08-22	16:11	68° 17,976'	101° 44,321'	Monster Net ↑	113.13	310	10.1	4.9	3.652	1003.44	81	0
3	QMGM	Basic	2018-08-22	16:57	68° 17,984'	101° 44,474'	Box Core ↓	111.55	302	12.4	2.0	3.859	1003.63	97	0
3	QMGM	Basic	2018-08-22	16:59	68° 17,985'	101° 44,476'	Box core (bottom)	111.59	315	14.9	1.2	3.781	1003.65	98	0
3	QMGM	Basic	2018-08-22	17:01	68° 17,982'	101° 44,470'	Box Core ↑	111.82	318	15.0	1.7	3.835	1003.65	98	0
3	QMGM	Basic	2018-08-22	17:14	68° 17,982'	101° 44,345'	Agassiz Trawl ↓	111.98	329	6.3	4.9	3.830	1003.86	86	0
3	QMGM	Basic	2018-08-22	17:27	68° 17,799'	101° 43,434'	Agassiz Trawl ↑	110.83	312	12.0	1.3	3.668	1003.71	98	0
3	QMGM	Basic	2018-08-22	17:45	68° 18,203'	101° 44,548'	Gravity Core ↓	113.08	323	12.6	1.3	3.228	1003.80	99	0
3	QMGM	Basic	2018-08-22	17:49	68° 18,197'	101° 44,562'	Gravity Core Bot	113.63	330	11.6	1.3	3.669	1003.71	99	0
3	QMGM	Basic	2018-08-22	17:52	68° 18,192'	101° 44,568'	Gravity Core ↑	115.15	331	12.6	1.3	3.674	1003.80	99	0
3	101	Basic	2018-08-27	0:33	74° 16,919'	82° 54,193'	CTD Rosette ↑	787.58	296	8.0	0.4	0.719	1007.72	99	0
3	101	Basic	2018-08-27	0:34	74° 17,080'	82° 53,509'	CTD Rosette ↓	794.95	292	6.7	0.3	0.794	1007.66	99	0
3	322	CTD	2018-08-27	3:43	74° 29,996'	80° 33,013'	CTD Rosette ↓	671.11	244	9.7	0.4	1.294	1006.39	99	0
3	322	CTD	2018-08-27	4:58	74° 29,649'	80° 38,686'	CTD Rosette ↑	669.97	229	7.4	0.3	1.344	1006.23	99	0
3	site 1.1 (Man	Coring	2018-08-27	18:33	76° 28,821'	78° 44,396'	Box Core ↓	124.8	149	3.0	1.7	-0.091	1003.77	81	0
3	site 1.1 (Man	Coring	2018-08-27	18:36	76° 28,835'	78° 44,428'	Box core (bottom)	124.27	165	1.7	2.3	0.023	1003.76	78	0
3	site 1.1 (Man	Coring	2018-08-27	18:39	76° 28,845'	78° 44,461'	Box Core ↑	124.63	259	0.4	2.2	0.131	1003.78	80	0
3	site 1.1 (Man	Coring	2018-08-27	19:30	76° 28,890'	78° 43,784'	Piston Core ↓	118.86	194	0.6	3.8	-0.138	1003.94	77	0
3	site 1.1 (Man	Coring	2018-08-27	19:36	76° 28,879'	78° 43,834'	Piston Core on Bot	119.43	235	0.0	3.1	-0.173	1003.98	79	0
3	site 1.1 (Man	Coring	2018-08-27	19:41	76° 28,876'	78° 43,844'	Piston Core ↑	119.55	186	0.0	3.2	-0.154	1004.02	82	0
3	101	Basic	2018-08-27	23:30	76° 22,796'	77° 23,736'	Secchi Disk ↓	361.4	255	8.6	1.2	2.265	1004.56	86	0
3	101	Basic	2018-08-27	23:33	76° 22,812'	77° 23,710'	Secchi Disk ↑	361.27	245	7.8	1.1	2.231	1004.58	88	0
3	101	Basic	2018-08-27	23:33	76° 22,815'	77° 23,701'	CTD Rosette ↓	360.7	229	7.0	1.1	2.232	1004.60	88	0
3	101	Basic	2018-08-28	0:34	76° 23,404'	77° 23,218'	CTD Rosette ↑	350.4	250	4.6	2.4	2.154	1004.67	83	0
3	101	Basic	2018-08-28	0:54	76° 22,988'	77° 22,969'	Tucker Net ↓	357.77	272	7.4	0.7	2.296	1004.65	90	0
3	101	Basic	2018-08-28	1:11	76° 23,629'	77° 22,485'	Tucker Net ↑	335.97	285	7.6	0.5	2.222	1004.73	90	0
3	Near trinity	CTD	2018-08-28	1:14	76° 23,694'	77° 23,127'	CTD Rosette ↑	335.02	260	10.3	0.8	2.154	1004.59	91	0
3	101	Basic	2018-08-28	1:36	76° 22,896'	77° 23,216'	Monster Net ↓	360.61	305	2.5	1.6	2.237	1004.67	88	0
3	101	Basic	2018-08-28	2:00	76° 22,969'	77° 23,247'	Monster Net ↑	358.76	244	0.6	1.4	2.238	1004.74	90	0
3	101	Basic	2018-08-28	2:12	76° 23,022'	77° 23,180'	CTD Rosette ↓	356.64	292	3.6	2.3	2.234	1004.76	84	0
3	101	Basic	2018-08-28	2:22	76° 23,067'	77° 23,123'	CTD Rosette ↑	356.23	19	0.2	1.0	2.230	1004.63	89	0
3	101	Basic	2018-08-28	2:44	76° 22,950'	77° 24,593'	Box Core ↓	372.78	35	0.0	1.1	2.264	1004.63	85	0
3	101	Basic	2018-08-28	2:59	76° 22,954'	77° 24,713'	Box Core ↑	373.43	247	4.0	0.7	2.299	1004.51	91	0
3	101	Basic	2018-08-28	3:15	76° 22,769'	77° 23,578'	Agassiz Trawl ↓	361.85	262	5.1	0.8	2.260	1004.68	91	0
3	101	Basic	2018-08-28	3:48	76° 23,530'	77° 24,202'	Agassiz Trawl ↑	339.75	317	7.0	0.7	2.216	1004.60	89	0
3	Near trinity	CTD	2018-08-28	11:20	77° 27,653'	75° 55,542'	Helicopter ↓	27.44	200	11.6	-1.1	-0.715	1004.94	91	0
3	Near trinity	CTD	2018-08-28	12:06	77° 27,740'	75° 54,571'	Secchi Disk ↓	28.2	206	10.9	-0.6	-0.685	1005.07	90	0
3	Near trinity	CTD	2018-08-28	12:08	77° 27,735'	75° 54,539'	Secchi Disk ↑		197	4.0	-0.4	-0.662	1005.03	89	0
3	Near trinity	CTD	2018-08-28	12:16	77° 27,721'	75° 54,316'	CTD Rosette ↓	554	242	1.9	-0.2	-0.668	1005.07	88	0
3	106	lander	2018-08-28	22:11	76° 18,471'	75° 21,159'	Zodiac ↓	386.01	167	2.7	0.4	2.060	1006.10	100	0
3	106	lander	2018-08-28	23:16	76° 18,472'	75° 21,473'	Zodiac ↑	388.24	187	2.9	0.2	2.172	1006.15	100	0
3	115	Basic	2018-08-29	4:21	76° 19,914'	71° 11,802'	Rosette ↓	685.08	96	4.6	2.2	3.144	1005.70	99	0
3	115	Basic	2018-08-29	4:50	76° 20,169'	71° 11,839'	Rosette ↑	667.56	170	0.4	3.0	3.188	1005.62	99	0
3	115	Basic	2018-08-29	4:58	76° 20,174'	71° 11,946'	Tucker Net ↓	666.69	74	2.3	2.9	3.124	1005.65	99	0
3	115	Basic	2018-08-29	5:15	76° 19,826'	71° 12,506'	Tucker Net ↑	654.23	108	7.2	1.9	3.118	1005.63	99	0
3	115	Basic	2018-08-29	5:32	76° 19,846'	71° 11,770'	Monster Net ↓	651.69	75	4.8	2.1	3.241	1005.62	98	0
3	115	Basic	2018-08-29	6:08	76° 20,085'	71° 11,491'	Monster Net ↑	668.62	94	5.0	3.4	3.141	1005.43	88	0
3	115	Basic	2018-08-29	6:21	76° 19,922'	71° 11,020'	Rosette ↓	659.51	107	6.5	2.7	3.142	1005.33	90	0
3	115	Basic	2018-08-29	7:27	76° 19,905'	71° 10,693'	Rosette ↑	660.67	103	0.8	3.1	3.114	1005.09	87	0
3	115	Basic	2018-08-29	7:40	76° 19,893'	71° 10,649'	Box Core ↓	660.91	164	2.3	3.1	3.192	1005.20	88	0

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3	115	Basic	2018-08-29	7:50	76° 19,894'	71° 10,572'	Box core (bottom)	662.29	152	1.5	3.2	3.127	1005.17	87	0
3	115	Basic	2018-08-29	8:00	76° 19,901'	71° 10,455'	Box Core ↑	665.39	102	3.6	3.5	3.122	1005.16	86	0
3	115	Basic	2018-08-29	8:08	76° 19,968'	71° 10,624'	Agassiz Trawl ↓	661.53	134	2.7	2.7	3.089	1005.15	87	0
3	115	Basic	2018-08-29	8:53	76° 19,728'	71° 08,292'	Agassiz Trawl ↑	657.96	127	2.7	2.5	3.116	1004.90	91	0
3	ba-05	Mooring	2018-08-29	12:47	75° 48,259'	70° 12,361'	Mooring ↑	545.93	64	4.6	1.8	3.022	1003.90	98	0
3	ba-06	Mooring	2018-08-29	14:23	75° 39,463'	70° 24,797'	Mooring ↑	533	27	5.7	1.9	3.953	1003.17	93	0
3	Argo buoy	Argo	2018-08-29	23:00	73° 54,325'	69° 08,873'	Zodiac ↓	737.69	296	14.9	2.1	3.326	1000.57	94	0
3	Argo buoy	Argo	2018-08-29	23:12	73° 54,459'	69° 08,919'	Argo buoy ↑	16.46	306	13.5	2.6	3.309	1000.79	92	0
3	Argo buoy	Argo	2018-08-29	23:23	73° 54,459'	69° 08,679'	Zodiac ↑		314	11.2	2.3	3.399	1000.71	89	0
3	Site 1.5	Coring	2018-08-31	18:41	67° 17,019'	63° 54,642'	Box Core ↓	609.04	13	0.4	7.9	4.360	1005.99	60	0
3	Site 1.5	Coring	2018-08-31	18:54	67° 17,047'	63° 54,620'	Box Core on Bot	609.08	85	3.0	7.8	2.101	1005.96	69	0
3	Site 1.5	Coring	2018-08-31	19:06	67° 17,078'	63° 54,599'	Box Core ↑	609.07	41	1.3	7.5	2.009	1005.95	62	0
3	Site 1.5	Coring	2018-08-31	19:56	67° 17,078'	63° 54,574'	Piston Core ↓	609.22	69	2.3	6.2	2.465	1006.06	71	0
3	Site 1.5	Coring	2018-08-31	20:09	67° 17,063'	63° 54,546'	Piston Core Bot	609.33	41	4.6	5.7	2.550	1006.12	78	0
3	Site 1.5	Coring	2018-08-31	20:31	67° 17,055'	63° 54,252'	Piston Core ↑	610.05	31	7.8	6.0	2.832	1006.44	62	0
3	177	Basic	2018-09-01	10:03	67° 28,817'	63° 40,694'	Secchi Disk ↓	694.41	6	9.1	2.8	1.351	1003.63	93	0
3	177	Basic	2018-09-01	10:06	67° 28,822'	63° 40,706'	Secchi Disk ↑	694.6	360	7.4	2.7	1.347	1003.62	93	0
3	177	Basic	2018-09-01	10:10	67° 28,816'	63° 40,660'	CTD Rosette ↓	694.16	359	8.9	2.9	1.324	1003.48	90	0
3	177	Basic	2018-09-01	11:03	67° 28,846'	63° 40,251'	CTD Rosette ↑	658.34	254	4.0	2.6	1.302	1003.24	89	0
3	177	Basic	2018-09-01	13:13	67° 28,677'	63° 40,946'	Monster Net ↓	691.73	14	3.8	2.7	1.103	1002.57	94	0
3	177	Basic	2018-09-01	13:53	67° 28,546'	63° 41,559'	Monster Net ↑	677.71	2	4.8	2.5	1.514	1002.17	96	0
3	177	Basic	2018-09-01	14:19	67° 28,730'	63° 40,348'	Tucker Net ↓	558.57	13	4.8	2.7	1.627	1001.90	95	0
3	177	Basic	2018-09-01	14:39	67° 28,695'	63° 38,505'	Tucker Net ↑	694.91	16	8.8	2.6	1.581	1001.82	96	0
3	177	Basic	2018-09-01	14:55	67° 28,705'	63° 40,911'	Agassiz Trawl ↓	693.52	35	4.4	2.9	1.798	1001.60	93	0
3	177	Basic	2018-09-01	15:39	67° 28,342'	63° 38,538'	Agassiz Trawl ↑	569.77	55	9.9	2.2	1.677	1001.13	99	0
3	177	Basic	2018-09-01	16:59	67° 28,984'	63° 40,755'	CTD Rosette ↓	696.48	75	2.9	2.9	1.879	1000.58	99	0
3	177	Basic	2018-09-01	18:06	67° 28,999'	63° 40,844'	CTD Rosette ↑	695.79	10	5.9	4.5	1.856	999.95	91	0
3	Sunneshine fj	Basic	2018-09-03	12:33	66° 36,352'	61° 43,497'	Gravity Core ↓	165	151	9.7	3.8	0.589	1006.66	73	0
3	Sunneshine fj	Basic	2018-09-03	12:41	66° 36,382'	61° 43,473'	Gravity Core ↑	161	141	10.7	2.6	0.608	1006.64	77	0
3	Sunneshine fj	Basic	2018-09-03	12:55	66° 36,399'	61° 43,553'	CTD Rosette ↓	160	331	0.2	3.3	0.594	1006.94	76	0
3	Sunneshine fj	Basic	2018-09-03	13:20	66° 36,399'	61° 43,553'	CTD Rosette ↑	164	331	0.2	3.3	0.594	1006.94	76	0

Leg	Cast #	Station	Start date UTC	Time UTC	Latitude (N)	Longitude (W)	Bottom depth (m)	Cast depth (m)	Comments	Rosette Type	init.
Leg 1											
1	001	N01 (356)	31 mai 2018	18:07	60°49,836	064°40,973	386	378	Btl 7, 11 and 13 leak, nitrate captor malfunction	Nutrients	pg
1	002	N02 (354)	31 mai 2018	22:02	60°58,373	064°46,420	566	555	nitrate captor malfunction	Nutrients	cw
1	003	N03 (352)	1 juin 2018	1:01	61°9,008	064°49,152	419	408	nitrate captor malfunction	Nutrients	cw
1	004	4	1 juin 2018	14:21	62°2,425	069°36,892	283	274	Change of ISUS (nitrate captor)	Nutrients	cw
1	005	05 (FB01)	2 juin 2018	21:38	64°17,202	078°13,710	239	228		Nutrients	cw
1	006	6	3 juin 2018	1:20	64°13,325	078°37,169	266	258		Nutrients	pg
1	007	07 (FB02)	3 juin 2018	3:31	64°3,904	079°3,730	270	259	Élastique des bouteilles12 et 15 à vérifier	Nutrients	cw
1	008	8	3 juin 2018	5:52	63°56,916	079°34,018	316	308		Nutrients	cw
1	009	09 (FB03)	3 juin 2018	14:57	63°43,734	079°55,686	101	92		Bio	pg
1	010	09 (FB03)	3 juin 2018	20:27	63°43,219	079°55,325	100	91		Chem	cw
1	011	10	4 juin 2018	2:10	63°26,752	079°26,489	199	191		Nutrients	cw
1	012	11	4 juin 2018	13:39	62°51,899	078°53,807	316	306		Bio	pg
1	013	11	4 juin 2018	19:01	62°52,602	078°51,862	309	300		Chem	cw
1	014	12	5 juin 2018	7:52	63°23,750	081°13,523	83	74		Nutrients	pg
1	015	13	5 juin 2018	10:06	63°15,859	081°40,169	144	134	Élastique 13	Nutrients	cw
1	016	14	5 juin 2018	11:35	63°11,786	081°51,268	180	170		CTD profil	cw
1	017	15	5 juin 2018	14:48	63°11,633	081°55,146	185	177		Bio	cw
1	018	15	5 juin 2018	17:45	63°10,512	081°50,983	189	179		Chem	pg
1	019	16	6 juin 2018	16:32	62°16,776	085°54,362	134	125		Bio	pg
1	020	16	6 juin 2018	21:32	62°17,358	085°51,473	132	122		Chem	cw
1	021	17	7 juin 2018	21:56	63°11,070	090°2,066	90	80		Bio-Chem	pg
1	022	18	8 juin 2018	8:39	63°42,830	088°25,020	114	104		Chem	cw
1	023	18	8 juin 2018	13:38	63°44,003	088°26,204	112	102		Bio	pg
1	024	19	9 juin 2018	12:39	61°50,879	092°6,622	86	75		Bio	pg
1	025	19	9 juin 2018	15:31	61°50,810	092°7,949	78	69		Chem	cw
1	026	20	10 juin 2018	2:38	61°22,537	090°56,520	109	100		Nutrients	cw
1	027	21	10 juin 2018	13:48	60°54,673	089°21,520	147	137		Bio	pg
1	028	21	10 juin 2018	17:44	60°54,655	089°19,774	144	135		Chem	cw
1	029	22	11 juin 2018	13:09	60°25,398	094°0,130	65	54		Bio	pg
1	030	22	11 juin 2018	14:39	60°25,272	094°0,204	63	53		Chem	cw
1	031	23 (M6)	12 juin 2018	3:25	60°55,376	091°46,907	110	100		Nutrients	pg
1	032	24	12 juin 2018	18:36	61°41,791	087°45,842	185	176		Bio	cw
1	033	24	12 juin 2018	22:47	61°42,646	087°47,326	186	177		Chem	pg
1	034	25	13 juin 2018	7:02	62°1,315	087°0,524	144	135		Chem	cw
1	035	25	13 juin 2018	13:24	62°0,229	086°58,889	149	139		Bio	pg
1	036	26	14 juin 2018	2:00	62°12,226	088°22,656	129	119		Nutrients	cw
1	037	27	14 juin 2018	12:13	62°34,998	090°55,376	65	55		Nutrients	pg
1	038	28	15 juin 2018	1:23	62°24,874	089°49,945	160	150		Nuts-Chem	pg
1	039	29	16 juin 2018	13:09	61°46,182	084°18,490	175	164		Chem	cw
1	040	31	18 juin 2018	18:24	57°30,010	091°47,822	46	37		Nutrients	cw
1	041	32	19 juin 2018	16:47	56°59,052	088°7,031	31	23		Bio	pg
1	042	32	19 juin 2018	19:31	56°58,854	088°8,749	34	24		Chem	cw
1	043	34	20 juin 2018	22:23	56°30,371	086°53,653	45	36		Bio	cw
1	044	34	21 juin 2018	1:13	56°30,008	086°52,052	43	33		Chem	pg
1	045	35	22 juin 2018	2:47	57°10,771	086°29,970	60	51		Nutrients	cw
1	046	36	22 juin 2018	15:24	57°46,442	086°1,865	126	116		Chem	pg
1	047	36	22 juin 2018	18:02	57°46,499	086°1,544	125	115		Bio	cw
1	048	37	23 juin 2018	3:11	58°28,150	086°13,528	166	157		Nutrients	pg
1	049	38	23 juin 2018	16:06	58°43,346	086°18,274	178	169		Bio	cw
1	050	38	23 juin 2018	19:21	58°43,835	086°18,086	177	168		Chem	pg
1	051	39	24 juin 2018	6:24	58°28,518	087°26,321	180	171		Nutrients	cw
1	052	40	24 juin 2018	16:21	58°13,960	088°33,799	90	80	several ship backwashs	Bio	pg
1	053	40	24 juin 2018	18:51	58°14,407	088°34,952	85	75		Chem	cw
1	054	41	25 juin 2018	4:22	58°1,164	089°46,828	71	62		Nutrients	pg
1	055	15	27 juin 2018	12:32	63°11,470	081°57,827	190	181	bottle 14 leaks	Chem	pg
1	056	44	28 juin 2018	17:16	59°58,507	091°57,012	100	92		Bio	cw
1	057	44	28 juin 2018	19:03	59°58,514	091°57,016	98	90		Chem	pg
1	058	45	30 juin 2018	13:55	57°13,247	091°57,373	16	11		Basic-01	cw
1	059	45	30 juin 2018	20:58	57°17,809	092°3,784	19	11		Basic-02	pg
1	060	W-T Stn1	1 juillet 2018	11:30	57°23,927	092°4,379	15	8		Basic-01	cw
1	061	W-T Stn2	1 juillet 2018	12:32	57°23,756	091°58,567	27	20		Basic-02	pg
1	062	W-T Stn3	1 juillet 2018	13:20	57°23,629	091°52,021	32	22		Basic-03	cw
1	063	46	1 juillet 2018	14:37	57°30,131	091°48,966	40	32		Bio	pg

1	064	46	1 juillet 2018	17 :43	57°29,635	091°49,030	45	36		Chem	cw
Leg 2a											
2a	001	731	8 juillet 2018	13:11	55°24,480	077°55,678	124	118	Valeur de PNF douteuses	Nuts	SC
2a	002	730	8 juillet 2018	19:08	56°11,056	076°43,398	138	129		Nuts	SC
2a	003	736	9 juillet 2018	11:08	58°25,383	078°18,743	99	87		Basic	SC
2a	004	689	11 juillet 2018	23:01	62°20,541	075°32,087	120	112		Basic	SC
2a	005	341	12 juillet 2018	14:33	61°57,861	070°45,894	312	301		Nuts	SC
2a	006	341	12 juillet 2018	17:21	61°57,490	070°45,306	307	297			SC
Leg 2b											
2b	007	1	16 juillet 2018	13:57	68°18,584	060°23,549	1585	993		IPS18	CM
2b	008	0	17 juillet 2018	1:50	69°17,513	060°42,767	1747	988		float	MP
2b	009	2	17 juillet 2018	12:59	68°2,158	061°27,793	1678	990		IPS18	CM
2b	010	3	18 juillet 2018	13:04	67°52,009	062°21,317	1090	989		IPS18	MP
2b	011	5	19 juillet 2018	12:28	67°28,919	062°47,006	355	345		IPS18	CM
2b	012	4	21 juillet 2018	13:28	67°32,401	063°33,845	450	440		IPS18	CM
2b	013	6	22 juillet 2018	12:48	67°14,336	064°38,261	230	221		IPS18	CM
Leg 2c											
2c	014	Trawl 1	25 juillet 2018	8:00	63°39,680	068°32,351	71	61		Nutrient	pg sc
2c	015	Outer bay A	25 juillet 2018	21:08	63°7,652	067°26,368	343	334		Nutrient	SC
2c	016	St. 12C	25 juillet 2018	23:06	63°4,868	067°25,584	343	334		Nutrient	SC
2c	017	St. 13C	26 juillet 2018	8:16	62°41,213	066°46,375	203	192		Nutrient	PG
2c	018	St.20D	26 juillet 2018	12:56	62°50,620	066°35,632	182	146		Nutrient	SC
2c	019	St. 9b	26 juillet 2018	21:17	62°40,603	066°29,303	482	472		Nutrient	SC
2c	020	Sponge Site 5	27 juillet 2018	19:41	60°24,030	062°54,018	299	289		Nutrient	PG
2c	021	Non-Sponge5	28 juillet 2018	3:10	59°13,484	061°49,585	149	138		Nutrient	SC
2c	022	non-Sponge4	28 juillet 2018	6:12	59°18,647	061°1,004	201	193		Nutrient	SC
2c	023	non-Sponge 3	28 juillet 2018	9:52	59°22,990	060°16,097	624	609		Nutrient	PG
2c	024	Non-Sponge2	28 juillet 2018	23:25	59°28,547	059°26,686	1948	1938	No PAR, no nitrate sensor	Nutrient	SC
2c	025	Non-Sponge1	29 juillet 2018	4:30	59°32,018	058°38,125	2571	2563	No PAR, no nitrate sensor	Nutrient	PG
2c	026	Saglek DFO1	29 juillet 2018	16:58	60°27,095	061°15,244	539	528		Mooring	PG
2c	027	Saglek DFO1	29 juillet 2018	22:45	60°27,809	061°15,767	512	507		Mooring	SC
2c	028	Sponge site 4	30 juillet 2018	7:31	60°27,614	062°7,021	365	360		Nutrient	SC
2c	029	Sponge site 3	30 juillet 2018	15:27	60°28,051	061°17,724	399	391		Nutrient	PG
2c	030	Saglek DFO3	31 juillet 2018	1:04	60°27,974	061°6,454	1134	1124		Nutrient	SC
2c	031	DFO-750	31 juillet 2018	23:43	60°27,864	061°12,983	716	709		Nutrient	PG
2c	032	DFO-5	2 août 2018	0:25	60°27,922	060°35,747	1429	1419	No PAR, no nitrate sensor	Nutrient	SC
2c	033	DFO-7/Sponge2	2 août 2018	17:21	60°27,911	060°23,046	1887	1878	No PAR, no nitrate sensor	Nutrient	PG
2c	034	DFO-8/Sponge1	3 août 2018	7:37	60°28,111	059°15,420	2438	2429		Nutrient	PG
2c	035	DFO-9	3 août 2018	22:45	60°28,297	058°48,817	2511	2503		Short Full	SC
2c	036	DFO-11	4 août 2018	10:23	60°26,503	057°5,400	3019	3009		Short Full	SC
2c	037	Hatton Basin	5 août 2018	5:35	61°26,237	060°40,123	604	595		ROV	SC
2c	038	H. Bassin	5 août 2018	8:05	61°26,402	060°39,674	604	298		Takuvik	SC
2c	039	Lophelia	6 août 2018	22:29	60°22,229	048°27,854	670	369	Cast cancelled	ROV	PG
2c	040	Lophelia	7 août 2018	0:23	60°21,958	048°27,554	753	746		ROV	PG
2c	041	Lophelia	7 août 2018	6:29	60°22,223	048°27,524	642	636		ROV	PG
2c	042	NLSE-07	9 août 2018	15:16	63°15,115	054°11,862	1172	1162		Nutrient	sc
2c	043	SW-Greenland-1	9 août 2018	21:49	63°59,843	057°30,241	1074	1065	No PAR, no nitrate sensor	Nutrient	pg
2c	044	SW-Greenland-2	10 août 2018	11:48	66°29,947	057°0,658	658	649		Nutrient	pg
2c	045	Disko Fan	10 août 2018	22:20	67°58,810	059°30,838	899	890		Benthic	pg
2c	046	SW Greenland3	11 août 2018	14:20	68°58,697	062°28,997	1886	1877	No PAR, no ISUS sensor	Nutrient	sc
2c	047	Scott Inlet	12 août 2018	12:21	71°22,517	070°4,631	243	239		Rov	pg
2c	048	Scott Inlet	12 août 2018	16:56	71°23,188	070°3,119	253	247		ROV	sc
2c	049	SC 0time 1	12 août 2018	22:39	71°22,596	070°4,301	250	245		ROV	pg
2c	050	SC SW-5K	12 août 2018	23:38	71°20,843	070°10,454	216	212		ROV	SC
2c	051	SC SW-1K	13 août 2018	0:35	71°22,325	070°5,602	247	242		ROV	pg
2c	052	SC 0time 2	13 août 2018	2:41	71°22,772	070°4,122	255	249		ROV	pg
2c	053	SC NW-5K	13 août 2018	3:57	71°24,536	070°10,685	548	544		ROV	pg
2c	054	SC NW-1K	13 août 2018	5:36	71°23,083	070°5,462	301	297		ROV	pg
2c	055	SC 0 time3	13 août 2018	6:34	71°22,716	070°4,259	256	253		ROV	sc
2c	056	SC SE-5K	13 août 2018	7:33	71°21,000	069°57,730	209	205		ROV	sc
2c	057	SC SE-1K	13 août 2018	9:39	71°22,337	070°2,858	202	200		ROV	sc
2c	058	SC NE-5K	13 août 2018	12:43	71°24,570	069°58,362	258	254			sc
2c	059	SC 0time4	13 août 2018	13:36	71°22,718	070°4,559	258	255			sc
Leg 3											
3	001	312	19 août 2018	12:53	69°10,560	100°41,632	64	54		basic	TL
3	002	312	19 août 2018	15:13	69°10,493	100°41,632	64	56		basic	SC

3	003	QMG1	21 août 2018	04:54	68°29,400	099°53,078	35	26		basic	TL
3	004	QMG2	21 août 2018	10:10	68°18,590	100°47,914	66	56		basic	TL
3	005	QMG4	22 août 2018	04:14	68°28,734	103°25,974	65	55		basic	TL
3	006	QMG3	22 août 2018	08:32	68°19,603	102°56,068	53	43		basic	TL
3	007	QMGM	22 août 2018	14:48	68°17,950	101°44,503	110	100		basic	TL
3	008	322	27 août 2018	03:47	74°29,934	080°33,355	662	654		basic	SC
3	009	101	27 août 2018	23:45	76°22,918	077°23,729	347	338		basic	TL
3	010	101	28 août 2018	02:16	76°23,039	077°23,147	352	41		Nutrient	TL
3	011	Near trinity	28 août 2018	12:21	77°27,720	075°54,215	553	543		Nutrient	SC
3	012	115	29 août 2018	04:26	76°19,957	071°11,796		100		Full	TL
3	013	115	29 août 2018	06:26	76°19,927	071°10,994	651	641		basic	SC
3	014	177									SC
3	015	177	1 septembre 2018	17:04	67°28,969	063°40,770	683	674			TL
3	016	Sunneshine	3 septembre 2018	13:11	66°36,419	061°43,714	163	154			SC

Leg	Name	Position	Affiliation	Network Investigator/Supervisor	Embark place	Embark date	Disembark place	Disembark date
Leg 1	Adebayo, Oye	Technician	University of Calgary	Hubert, Casey	Rankin Inlet	14-juin-18	Churchill	05-juil-18
Leg 1, Leg 2a	Ahmed, Mohamed	PhD Student	University of Calgary	Else, Brent	Quebec City	25-mai-18	Iqaluit	13-juil-18
Leg 2c	Aitken, Alec	Researcher/Professor	University of Saskatchewan	Aitken, Alec	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 2b	Alikacem, Yasmine	MSc Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2b	Andersson, Björn	PhD Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2b	Anhaus, Philipp	PhD Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2b	Arboit, Geneviève	PhD Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2c	Archambault, Philippe	Chief Scientist	Université Laval - QO	Archambault, Philippe	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 2a, Leg 2b, Le	Arduini Plaisant, Luca	Professional	Amundsen Science	Forest, Alexandre	Churchill	05-juil-18	Resolute Bay	16-août-18
Leg 1	Aubry, Cyril	Research Staff	Université Laval - QO	Fortier, Louis	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 2c	Auger, Vincent	Professional	Canadian SSF	Edinger, Evan / Archambault, Philippe	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 1	Babb, David	Research Staff	University of Manitoba - CEOS	Barber, David	Quebec City	25-mai-18	Rankin Inlet	14-juin-18
Leg 2b	Babin, Marcel	Chief Scientist	Sentinel North	Fortier, Martin	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2b	Bansept, Marc-Antoine	MSc Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 1	Barbedo de Freitas, Lucas	PhD Student	UQAR - ISMER - QO	Bélanger, Simon	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 1	Barber, David	Chief Scientist	University of Manitoba - CEOS	Barber, David	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 1	Barber, Lucette	Research Staff	University of Manitoba - CEOS	Barber, David	Rankin Inlet	14-juin-18	Churchill	05-juil-18
Leg 1, Leg 2a	Basu, Atreya	PhD Student	University of Manitoba - CEOS	Ehn, Jens	Quebec City	25-mai-18	Iqaluit	13-juil-18
Leg 3	Beaupré-Laperrière, Alexis	MSc Student	McGill University	Mucci, Alfonso	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2b	Bécu, Guislain	Research Staff	Université Laval - Takuvik	Babin, Marcel	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2b	Benoît-Gagné, Maxime	PhD Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 3	Bernard-Grand'Maison, Claire	MSc Student	University of Ottawa	Copland, Luke	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2c	Blackbird, Sabena	Professional	ATLAS-EU	van Oevelen, Dick	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 3	Boivin-Rioux, Aude	MSc student	UQAR	Gosselin, Michel	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2b	Boss, Emmanuel	Researcher/Professor	University of Maine	Fortier, Martin	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2c	Brake, Barry	Professional	Canadian SSF	Edinger, Evan / Archambault, Philippe	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 3	Brossard, Jade	MSc Student	UQAR - ISMER - QO	Montero-Serrano, J.-C. / St-Onge, G.	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2a	Callender, Katrina	Professional	NRC Montréal/University of Calgary	Greer, Charles/Hubert, Casey	Churchill	05-juil-18	Iqaluit	13-juil-18
Leg 1, Leg 2a	Cameron-Bergeron, Kasey	MSc Student	Université Laval - QO	Tremblay, Jean-Éric	Quebec City	25-mai-18	Iqaluit	13-juil-18
Leg 1	Campbell, Yanique	MSc Student	University of Manitoba - CEOS	Barber, David	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 2a, Leg 2c, Le	Caous, Solenne	Professional	Amundsen Science	Forest, Alexandre	Churchill	05-juil-18	Iqaluit	13-juil-18
Leg 1	Capelle, David	Postdoctoral Fellow	University of Manitoba - CEOS	Papakyriakou, Tim	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 2c	Chakraborty, Anirban	Postdoctoral Fellow	University of Calgary	Hubert, Casey	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 1	Chaudhuri, Punarbasu	Researcher/Professor	University of Manitoba - CEOS	Ehn, Jens	Rankin Inlet	14-juin-18	Churchill	05-juil-18
Leg 2a, Leg 2b, Le	Chawarski, Julek	PhD Student	Memorial University	Geoffroy, Maxime	Churchill	05-juil-18	Resolute Bay	16-août-18
Leg 2c	Chen, Shaomin	PhD Student	Dalhousie University	Sherwood, Owen	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 1	Chirkova (Saltymakova), Diana	Postdoctoral Fellow	University of Manitoba - CEOS	Stern, Gary	Quebec City	25-mai-18	Rankin Inlet	14-juin-18
Leg 2b	Cimoli, Emiliano	Postdoctoral Fellow	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 3	Corminboeuf, Anne	MSc Student	UQAR - ISMER - QO	Montero-Serrano, Jean-Carlos	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2c	Cote, David	Researcher/Professor	Fisheries and Oceans Canada	Cote, David	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 2c	Cramm, Margaret	Research Staff	Fisheries and Oceans Canada	Hubert, Casey	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 1	Dalman, Laura	MSc Student	University of Manitoba - CEOS	Barber, David	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 3	Dalton, Abigail	PhD Student	University of Ottawa	Copland, Luke	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 3	Darnis, Gérald	Research Staff	Université Laval - QO	Fortier, Louis	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2c	de Moura Neves, Barbara	Postdoctoral Fellow	Fisheries and Oceans Canada	Gilkinson, Kent	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 3	Delaigue, Louise	PhD Student	McGill University	Mucci, Alfonso	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2a	Deslongchamps, Gabrièle	Research Staff	Université Laval	Tremblay, Jean-Éric	Churchill	05-juil-18	Iqaluit	13-juil-18
Leg 3	Deslongchamps, Gabrièle	Research Staff	Université Laval	Tremblay, Jean-Éric	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2a, Leg 2b, Le	Dezutter, Thibaud	Research Staff	Université Laval - QO	Fortier, Louis	Churchill	05-juil-18	Resolute Bay	16-août-18
Leg 2c	Dhifallah, Fatma	MSc Student	UQAR - ISMER - QO	Montero-Serrano, Jean-Carlos	Iqaluit	16-août-18	Resolute Bay	16-août-18
Leg 2c	Dicker, Megan	TBD	Nunatsiavut Government	Laing, Rodd	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 1	Downton, Matt	Professional	Amundsen Science	Forest, Alexandre	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 3	Dumais, Philippe-Olivier	MSc Student	Université Laval - QO	Archambault, Philippe	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2c	Edinger, Evan	Researcher/Professor	Memorial University	Edinger, Evan	Iqaluit	24-juil-18	Resolute Bay	16-août-18

Leg 2b	Ferland, Joannie	Research Staff	Université Laval - Takuvik	Babin, Marcel	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 3	Forest, Alexandre	Chief Scientist	Amundsen Science	Forest, Alexandre	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2b	Forget, Marie-Hélène	Research Staff	Université Laval - Takuvik	Babin, Marcel	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2a	Fortin, Gabrielle	Research Staff	Université Laval - QO	Tremblay, Jean-Éric	Churchill	05-juil-18	Iqaluit	13-juil-18
Leg 2b	Fowler, Victoria	PhD Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 3	Freyria, Nastasia	PhD Student	Université Laval - QO	Lovejoy, Connie	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 1	Gagnon, Jonathan	Research Staff	Université Laval - QO	Tremblay, Jean-Éric	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 1	Gao, Zhiyuan (Jeff)	MSc Student	University of Manitoba - CEOS	Wang, Feiyue	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 3	Garbo, Adam	Research Staff	Carleton University	Muller, Derek	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2b	Gévry, Marie-France	Research Staff	Sentinel North	Fortier, Martin	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 3	Gordon, Colin	Contractor	Marine Wildlife Observer	Darnis, Gérald	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 3	Grant, Cindy	Research Staff	Université Laval - QO	Archambault, Philippe	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2b	Gremion, Gwenaëlle	PhD Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2c	Guarin, Gustavo Adolfo	PhD Student	Université Laval - QO	Archambault, Philippe	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 2a, Leg 2b	Guérin, Sébastien	PhD Student	Université Laval - QO	Lavaud, Johan	Churchill	05-juil-18	Iqaluit	24-juil-18
Leg 1	Guillot, Pascal	Professional	Amundsen Science - QO	Forest, Alexandre	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 2c	Guillot, Pascal	Professional	Amundsen Science - QO	Forest, Alexandre	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 3	Guilmette, Caroline	Research Staff	Université Laval - QO	Fortier, Louis/Guillaume Massé	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2c	Hamp, Meghan	BSc Student	University of Saskatchewan	Aitken, Alec	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 1	Harasyn, Madison	MSc Student	University of Manitoba - CEOS	Barber, David	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 2c	Hayes+A41+B133:G133+B133:I133	Researcher/Professor	Fisheries and Oceans Canada	Gilkinson, Kent	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 2c	Hogan, Holly	Professional	Environment Canada and Climate Change	Gjerdrum, Carina	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 1	Hussherr, Rachel	Research Staff	UQAR - ISMER - QO	Bélanger, Simon / Mundy, C.J.	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 1	Huyghe, Samantha	MSc Student	University of Manitoba - CEOS	Kuzyk, ZouZou	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 2c, Leg 3	Izett, Robert	PhD Student	University of British Columbia	Tortell, Philippe	Iqaluit	24-juil-18	Quebec City	07-sept-18
Leg 2a, Leg 3	Izquierdo, Disney	MSc Student	UQAM	Lavaud, Johann/Juneau, Philippe	Churchill	05-juil-18	Iqaluit	13-juil-18
Leg 1, Leg 2a	Jacquemot, Loïc	PhD Student	Université Laval - QO	Lovejoy, Connie	Quebec City	25-mai-18	Iqaluit	13-juil-18
Leg 2c	Jaggi, Aprami	Postdoctoral Fellow	University of Calgary	Hubert, Casey	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 3	Ji, Wanying	MSc Student	Dalhousie University	Thomas, Helmuth	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 3	Jones-Williams, Kirstie	PhD Student	British Antarctic Survey	Manno, Clara	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2a	Joyal, Gabriel	Technician	Amundsen Science	Forest, Alexandre	Churchill	05-juil-18	Iqaluit	13-juil-18
Leg 3	Joyal, Gabriel	Technician	Amundsen Science	Forest, Alexandre	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 1	Karimialavijeh, Pardis	Postdoctoral Fellow	University of Manitoba - CEOS	Stern, Gary	Quebec City	25-mai-18	Rankin Inlet	14-juin-18
Leg 2b	Karp-Boss, Lee	Researcher/Professor	University of Maine	Fortier, Martin	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2b	Katlein, Christian	Postdoctoral Fellow	Alfred Wegener Institute	Fortier, Martin	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 1	Kirillov, Sergei	Research Staff	University of Manitoba - CEOS	Barber, David	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 2c	Koch, Christine	Media/Artist	Memorial University	Edinger, Evan	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 2b	Lagunas Morales, José	Research Staff	Université Laval - Takuvik	Babin, Marcel	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2b	Lambert-Girard, Simon	Postdoctoral Fellow	Université Laval - Takuvik	Babin, Marcel	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 1	Landry, David	Research Staff	University of Manitoba - CEOS	Barber, David	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 2b	Larouche, Raphaël	MSc Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2c	Lauridsen, Bodil	Researcher/Professor	Geological Survey of Greenland	Bjerager, Morton	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 2b	Lebrun, Marion	PhD Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 1, Leg 2a	Lee, Janghan	PhD Student	Université Laval - QO	Tremblay, Jean-Éric	Quebec City	25-mai-18	Iqaluit	13-juil-18
Leg 2b	Lévesque-Desrosiers, Félix	MSc Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2b	Li, Juan	PhD Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2a	Linkowski, Thomas	Technician	Amundsen Science	Forest, Alexandre	Churchill	05-juil-18	Iqaluit	13-juil-18
Leg 2c, Leg 3	Linkowski, Thomas	Technician	Amundsen Science	Forest, Alexandre	Iqaluit	24-juil-18	Quebec City	07-sept-18
Leg 2a, Leg 2b	Lizotte, Martine	Research Staff	Université Laval - QO	Levasseur, Maurice	Churchill	05-juil-18	Iqaluit	24-juil-18
Leg 2c	Lockhart, Peter	Professional	Canadian SSF	Edinger, Evan / Archambault, Philippe	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 1, Leg 2a	Loria, Ainsleigh	Research Staff	University of Manitoba - CEOS	Stern / Fortier / Tremblay	Quebec City	25-mai-18	Iqaluit	13-juil-18
Leg 1	Major, Julie	BSc Student	UQAR - ISMER - QO	Belanger, Simon / Mundy, C.J.	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 1	Mandryk, Rachel	BSc Student	University of Manitoba - CEOS	Papakyriakou, Tim	Quebec City	24-juil-18	Rankin Inlet	14-juin-18
Leg 3	Manning, Cara	Postdoctoral Fellow	University of British Columbia	Tortell, Philippe	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2b	Marec, Claudie	Research Staff	Université Laval - Takuvik	Babin, Marcel	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2a, Leg 2b	Marmillot, Vincent	Postdoctoral Fellow	Université Laval - QO	Tremblay, Jean-Éric	Churchill	05-juil-18	Iqaluit	24-juil-18

Leg 1	Matthes, Lisa	PhD Student	University of Manitoba - CEOS	Mundy, C.J.	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 1	McCullough, Greg	Research Staff	University of Manitoba - CEOS	Barber, David	Rankin Inlet	14-juin-18	Churchill	05-juil-18
Leg 2c	Meredyk, Shawn	Professional	Amundsen Science	Forest, Alexandre	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 3	Michaud, Luc	Professional	Amundsen Science	Forest, Alexandre	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 3	Montero Serrano, Jean Carlos	Researcher Professor	UQAR	Montero Serrano, Jean Carlos	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 1	Morisset, Simon	Professional	Amundsen Science	Forest, Alexandre	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 1, Leg 2a	Munson, Kathleen	Postdoctoral Fellow	University of Manitoba - CEOS	Wang, Feiyue	Quebec City	25-mai-18	Iqaluit	13-juil-18
Leg 2c	Murphy, Andrew	Professional	Fisheries and Oceans Canada	Cote, David	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 3	Nadaï, Gabrielle	MSc Student	Université Laval - QO	Fortier, Louis	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 3	Palu, Louie	Media/Artist	ArcticNet	Fortier, Louis	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 1	Papakyriakou, Tim	Researcher/Professor	University of Manitoba - CEOS	Papakyriakou, Tim	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 2c	Parzanini, Camilla	Technician	Memorial University	Mercier, Annie / Cote, David	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 2b	Perron, Christophe	MSc Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 1	Peterson, Keesha	Technician	CMO / University of Manitoba - CEOS	Barber, David / Mundy, C.J.	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 2c	Piccott, Kandice	Professional	Amundsen Science	Forest, Alexandre	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 2b	Picheral, Marc	Research Staff	Laboratoire d'Océanographie de Villefranc	Babin, Marcel	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 1, Leg 2a	Pierrejean, Marie	PhD Student	Université Laval - QO	Archambault, Philippe	Quebec City	25-mai-18	Iqaluit	13-juil-18
Leg 2b	Pitusi, Vanessa	MSc Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2c	Polcwiartek, Katarzyna	PhD student	University of Manitoba - CEOS	Stern, Gary	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 1	Pontbriand, Tommy	BSc Student	Université Laval - QO	Fortier, Louis	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 2c	Purcell, Karl	PhD Student	Université de Québec à Montréal	Hillaire-Marcel, Claude	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 2b	Randelhoff, Achim	Research Staff	Université Laval - Takuvik	Babin, Marcel	Iqaluit	14-juil-18	Iqaluit	25-juil-18
Leg 2b	Rehm, Eric	Research Staff	Université Laval - Takuvik	Babin, Marcel	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2b	Reimer, Jody	PhD Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2a	Robitaille, Rachelle	MSc Student	University of Toronto / Environment Cana	Jantunen, Liisa	Churchill	05-juil-18	Iqaluit	13-juil-18
Leg 3	Rodgers, Tim	PhD Student	University of Toronto / Environment Cana	Jantunen, Liisa	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 3	Rodriguez Cuicas, Maria Emilia	PhD Student	UQAR - ISMER	Montero-Serrano, Jean-Carlos	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 1, Leg 2a	Schembri, Sarah	PhD Student	Université Laval - QO	Fortier, Louis	Quebec City	25-mai-18	Iqaluit	13-juil-18
Leg 3	Schreiber, Lars	Research Staff	NRC Montréal/University of Calgary	Greer, Charles / Hubert, Casey	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 1	Singer, James	MSc Student	University of Manitoba - CEOS	Wang, Feiyue	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 3	Smith, Jesse	MSc Student	Carleton University	Muller, Derek	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 1	Snyder, Nolan	MSc Student	University of Manitoba - CEOS	Stern, Gary	Quebec City	25-mai-18	Rankin Inlet	14-juin-18
Leg 3	St-Hilaire-Gravel, Dominique	Professional	Amundsen Science	Forest, Alexandre	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 1	Stone, Michael	BSc Student	University of Calgary	Hubert, Casey	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 2a, Leg 2b	St-Onge, Joanie	MSc Student	Université Laval - QO	Levasseur, Maurice	Churchill	05-juil-18	Iqaluit	24-juil-18
Leg 2a, Leg 2b, Le	Tisné, Lou	Professional	Amundsen Science	Forest, Alexandre	Churchill	05-juil-18	Iqaluit	24-juil-18
Leg 2a	Tremblay, Jean-Éric	Chief Scientist	Université Laval - QO	Tremblay, Jean-Éric	Churchill	05-juil-18	Iqaluit	13-juil-18
Leg 2b	Trudeau, Jean-Marie	Professional	Sentinel North	Fortier, Martin	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 2c	Tulloch, Graham	Professional	ATLAS-EU	van Oevelen, Dick	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 1, Leg 2a	Van Doorn, Catherine	MSc Student	Université Laval - QO	Archambault, Philippe	Quebec City	25-mai-18	Iqaluit	13-juil-18
Leg 1	van Lohuizen, Christiaan (Kadir)	Media/Artist	University of Manitoba - CEOS	Barber, David	Quebec City	25-mai-18	Rankin Inlet	14-juin-18
Leg 3	Villeneuve, Vincent	MSc student	Université Laval	Tremblay, Jean-Éric	Resolute Bay	16-août-18	Quebec City	07-sept-18
Leg 2b	Wauthy, Maxime	PhD Student	Sentinel North	Gévry, Marie-France	Iqaluit	13-juil-18	Iqaluit	24-juil-18
Leg 1	Wilhelmy, Camille	CTD-Rosette Operator	Amund+D18:E18sen Science	Forest, Alexandre	Quebec City	25-mai-18	Churchill	05-juil-18
Leg 1	Wolfe, Teresinha	BSc Student	University of Manitoba - CEOS	Stern, Gary	Rankin Inlet	14-juin-18	Churchill	05-juil-18
Leg 1, Leg 2a	Yezhova, Yekaterina (Kate)	BSc Student	University of Manitoba - CEOS	Papakyriakou, Tim	Rankin Inlet	14-juin-18	Iqaluit	13-juil-18
Leg 2a	Ymana, Nicole	BSc Student	Nunavut Arctic College	Jantunen, Liisa	Churchill	05-juil-18	Iqaluit	13-juil-18
Leg 2c	Young, Catherine	MSc Student	Memorial University	Snelgrove, Paul	Iqaluit	24-juil-18	Resolute Bay	16-août-18
Leg 3	Zheng, Zhiyin (Zarah)	BSc Student	University of British Columbia	Tortell, Philippe	Resolute Bay	16-août-18	Quebec City	07-sept-18